American Concrete Institute
55-YEAR INDEX
1905-1959

AMERICAN CONCRETE INSTITUTE PUBLICATION

0

American Concrete Institute
55 - YEAR INDEX
1905 - 1959

24 September 1979

Index of Proceedings and Journal of the American Concrete Institute—with brief synopses of papers published in the Journal (1929-1959). Indexed are Proceedings V. 1-25, 1905-1928, which appeared solely as single-volume convention reports and Proceedings V. 26-55 which first appeared as the monthly Journal, V. 1-30, 1929-1959.

Compiled by Robert G. Wiedyke and Mary K. Hurd

Edited by Robert G. Wiedyke

AMERICAN CONCRETE INSTITUTE PUBLICATION

American Concrete Institute
P.O. Box 4754, Redford Station
Detroit 19, Michigan

Printed in U. S. A.

$9.00 — $4.50 to ACI members

Library of Congress Catalog Card Number 7-6419

Foreword

In 1947, in an effort to place within easy and constant reach of those who needed and wanted access to the important information published by the American Concrete Institute, a three-part program was undertaken. The first step was the 10-year index of the ACI JOURNAL, 1937-1947. The second step more than doubled the entries in the form of the 20-year index of JOURNAL papers covering 1929-1949. In 1955, a supplemental index covering the JOURNAL papers published in 1950-1954 was issued when it appeared that compilation of the current index would be delayed. This 55-year index closes the gap with the past, presenting a comprehensive index of all of the *Proceedings* of the Institute from its inception as the National Association of Cement Users in 1905 through the ACI JOURNAL of June, 1959.

The 55-year index differs only slightly from its predecessors: The synopsis section is confined to the papers published in the ACI JOURNAL, 1929-1959, and entries have been consolidated with a more liberal use of cross referencing. ACI publications not part of the *Proceedings* are not included.

All papers appearing in the ACI *Proceedings* in the 55 years are indexed by title, author, and subjects covered. The briefer items which have appeared over the years under various headings; Convention Question Box (QB), Job Problems and Practices (JPP), Letters from Readers (LR), and Problems and Practices (P&P); are indexed by subject only in most cases. The more recent Concrete Briefs sections (CB) are indexed in the same manner as papers. Published discussion of JOURNAL papers is noted along with the paper title. Each discusser is listed with the paper and individually.

The section under **Committee** lists ACI committees in the three main designation categories used during the 55 years, with the oldest designations carried first; i.e., first committees without number or letter designations are listed alphabetically, then committees designated by letter and number are listed numerically within alphabetical groupings followed by committees designated by number only listed numerically. Committees which treated similar subjects are not listed together, only under the designation used for publication of the material indexed. Where a committee number has been changed no attempt has been made to group or cross reference the material published under the various designations as the work of the last existing committee on the subject usually supersedes the work of its predecessors.

All entries are alphabetical throughout unless otherwise noted. Author, title, and subjects appear together in one index with the main part of each in bold type for easiest use.

Prior to 1929, the *Proceedings* of the Institute were published only in the yearly volume composed of papers presented at that year's convention. As more papers became available than convention time would allow, many were offered in printed form only. Since 1929, all papers published as part of the *Proceedings* of the Institute appear first in the ACI JOURNAL whether presented at a convention or not, and are at the end of the volume year bound into the familiar *Proceedings* without change. Therefore all papers published since the JOURNAL's inception belong to two volumes, that of the JOURNAL and that of the consecutive *Proceedings*. For example, a paper published in the first JOURNAL, say Title No. 26-8, is a part of *Proceedings* V. 26 and JOURNAL V. 1, the eighth paper in both volumes. Page numbers for both are the same. Reference to both *Proceedings* and JOURNAL volume may aid in finding references in libraries; however, throughout this index, reference is made solely to the consecutive *Proceedings* volume to avoid confusion.

The Institute will furnish prices of papers, JOURNAL issues, and *Proceedings* volumes on request. In cases where the requested material is out of print, and it is requested to do so, the Institute will arrange to have the material reproduced by the best method, at nominal cost.

In addition to the *Proceedings*, the Institute has published separately books and reports in the concrete field. Information regarding subjects and availability of these, which include ACI committee reports and standards, is available from Institute headquarters.

Use of the index

Information is listed in three categories for *Proceedings* papers:

1. **Title**	**Folded plate dome ideal for auditorium (55-28) Lyndon Welch Oct. 1958 . . . . 441**
2. **Author**	**Welch, Lyndon — Folded plate dome ideal for auditorium (55-28) Oct. 1958 . . . . 441**
3. **Subject**	**Folded plate dome — Auditorium (55-28) Oct. 1958 . . . . 441**

In some instances briefer material is indexed by subject only. The material within the parentheses will vary according to where and how the material was first presented. The following is a list of the abbreviations used and their significance:

(QB-19) — Convention Question Box. Appear in early *Proceedings* and were answers to questions submitted to a panel of experts. The number represents the *Proceedings* volume in which it appears.

(JPP 39-133) — Job Problems and Practices. A group of brief descriptions too short to be presented as a paper, which appeared in the JOURNAL, the issue of which is indicated in the entry. First number represents *Proceedings* volume and second is the consecutive item in the series which covered 10 years.

(LR 45-1) — Letters from Readers. Successor to JPP. First number represents *Proceedings* volume and the second number the letter in that volume.

(55-CB) — Concrete Briefs. Successor to LR. Number represents *Proceedings* volume.

(55-P&P) — Problems and Practices. Published question and answer forum appearing in the JOURNAL. Number represents *Proceedings* volume.

(V. 19) — Represents a paper appearing in *Proceedings* V. 19. No paper number assigned to papers published prior to *Proceedings* V. 26.

(55-28) — This title number represents paper No. 28 in *Proceedings* V. 55. A synopsis of each of these JOURNAL papers appears at the end of the index.

The month and year following the parenthetical material is the JOURNAL issue in which the material appeared; a year only is the year of the convention the *Proceedings* represent.

Published discussion of JOURNAL papers is identified with the paper title and with the discusser by "Disc."

Page numbers represent the initial page of the paper or section, and are the same for the *Proceedings* and JOURNAL in those years where both were published.

Contents

Index

A

B

C

E

J

K

M

N

O

Q

R

S

T

U

V

W

Synopses

The synopses which follow begin with the first issue of the JOURNAL of the American Concrete Institute which corresponds to ACI *Proceedings* V. 26. Papers in the first 25 *Proceedings* volumes, issued only as annual bound books, are not included. For more details on the contents of papers from these earlier volumes which are included in the index portion of this book, the reader is referred to the bound volumes for the corresponding years. In some cases, copies of early bound volumes may be purchased from ACI headquarters. Where bound volumes cannot be supplied, photostatic copies of papers can be made available at nominal cost.

Papers synopsized in this section covering *Proceedings* volumes 26-55, November 1929 to June 1959, inclusive, first appeared in the JOURNAL are available in reprint, JOURNAL, Bound Volume, or photostatic copy from ACI headquarters. Inquiries, containing pertinent titles and title numbers of papers and quantity desired, should be directed to Institute headquarters for up-to-date information on form in which available and cost.

The synopses below are listed in order of title number.

Proceedings V. 26

CONSTRUCTION SPECIFICATIONS FOR CONCRETE WORK ON ORDINARY BUILDINGS 26-1

Superseded by 27-40

ARTHUR R. LORD — Nov. 1929, pp. 1-17 (V. 26)

The first of a series of specifications to be prepared and issued under the auspices of the American Concrete Institute. The specification applies to concrete work in ordinary commercial or industrial buildings.

PERMISSIBLE OPENINGS IN CONSTRUCTION 26-2

ALBERT SMITH — Nov. 1929, pp. 24-28 (V. 26)

A progress report contributing to rational practice with respect to openings in concrete construction. Topics include: conditions requiring unframed openings, effect of openings of various sizes on stresses and deflections, effect of location of opening, special reinforcement about openings, shrinkage stresses at openings, early formwork removal, and recommended practice in design.

PORTLAND CEMENT STUCCO FINISHES 26-3

W. D. M. ALLAN — Nov. 1929, pp. 29-40 (V. 26)

A report of ACI Committee 401 giving information on best recognized practices governing successful application of portland cement stucco. The report covers the fundamentals of obtaining a good stucco job, including proper construction of building on which stucco is to be applied, requirements and preparation of various types of bases — masonry, frame, cast-in-place concrete; stucco reinforcement; selection of materials; proportioning; mixing, application; number and thickness of coats; controlling suction; curing; overcoating; and other important details.

DISINTEGRATION OF CONCRETE . . 26-4

G. M. WILLIAMS — Nov. 1929, pp. 41-56 (V. 26)

Summary of available knowledge of the nature of corrosion as found in concrete — its causes, effects and control in manufacture, curing, and insulation or protection. The most common forms of deterioration encountered may be classified under the headings of (1) acid action, (2) weathering, (3) action of sea water, and (4) action of alkali. Information is given on the reactions taking place in each case and recommendations are made for the prevention of such disintegration.

PROGRESS IN DETERMINING THE RELATION BETWEEN TEST CYLINDERS AND CONCRETE IN THE STRUCTURE. 26-5

HARLAN H. EDWARDS — Nov. 1929, pp. 57-64 (V. 26)

Tests on four college structures in Claremont, Calif., indicate that well-designed, placed, and cured concrete has strength higher than standard test cylinders, due to lowering of W/C by form absorption and percolation. Cylinders cast in unwaxed paper molds surrounded by wall concrete in curing, prove reliable indicators of concrete characteristics. Damp sand job-curing of cylinders is worthless. Slab concrete is generally of higher strength than walls of the same mix.

VARIATIONS IN STANDARD PORTLAND CEMENTS 26-6

P. H. BATES — Nov. 1929, pp. 65-95 (V. 26)

Discusses the variations in commercial portland cements as reflected by variations in their early and late strength, permeability, workability, reaction with building stone, shrinkage, plastic yield, heat of hydration, reactions to curing conditions, and color of concrete.

A SUMMARY OF THE RESULTS OF INVESTIGATIONS HAVING TO DO WITH VOLUMETRIC CHANGES IN CEMENTS, MORTARS AND CONCRETES, DUE TO CAUSES OTHER THAN STRESS 26-19

RAYMOND E. DAVIS — Feb. 1930, pp. 407-443 (V.26)

Presents in concise form the results of the principal investigations (prior to 1930) having to do with volume changes of concrete caused by variations in moisture and temperature conditions. Observed hygral volume change is affected by the composition and fineness of cement, mix proportions, type and gradation of aggregate, admixtures, consistency, moisture conditions, age, size and shape of mass, method of mixing and placing, absorptiveness of molds, and amount and distribution of reinforcement. Thermal expansion is affected by age of concrete, type of aggregate, type of cement, richness of mix, consistency, temperature range, moisture condition of concrete, and freezing and thawing.

SPECIFICATION FOR SUPPLYING FABRICATING AND SETTING REINFORCING STEEL ON ORDINARY BUILDINGS WITH A "STEEL SETTER'S PRIMER" 26-20

WILLIAM F. ZABRISKIE—Feb. 1930, pp. 444-466 (V. 26)

Superseded by 27-42

A companion piece to ACI Specification No. 502, "Concrete Work on Ordinary Buildings," and the two specifications cover the entire concrete work on ordinary buildings. The specification includes paragraphs on material, placing drawings, bar lists and bending details, placing details, etc.

As an appendix to the report, a "Steel Setter's Primer," presents the fundamentals of steel reinforcing for the man who places the steel. The author asks the steel worker to picture where the member would be likely to break if no steel were provided and helps him to conjure up the picture. Reinforcing in footings, columns, beams, slabs, cantilever beams and slabs, and retaining walls is discussed simply.

PROPOSED SPECIFICATIONS FOR READY-MIXED CONCRETE 26-21

MILES N. CLAIR — Feb. 1930, pp. 467-476 (V. 26)

This progress report of Committee 504 proposes a tentative specification for ready-mixed concrete and presents a discussion of the items where deviations from the usual standard specifications occur.

SPECIFICATIONS FOR THE SMALL JOB 26-22

S. C. HOLLISTER — Feb. 1930, pp. 477-490 (V. 26)

The engineer and owner desire the same high grade of construction on the small job as on the large job. The specification proposed here is based on the Joint Committee report but shortened in accordance with the needs and requirements of the small job.

RECOMMENDED PRACTICE FOR THE MANUFACTURE OF CONCRETE BLOCK AND BUILDING TILE 26-23

P. M. WOODWORTH — Feb. 1930, pp. 491-497 (V. 26)

Various divisions of the 1925 report of Committee P-6 are discussed in view of changes in plant practice and recently developed information. The author concludes that further research into manufacturing details is necessary so that the processes will be standardized.

DESIGN OF CONCRETE PRODUCTS PLANTS FOR SINGLE OR MULTIPLE SHIFT OPERATION 26-24

BENJAMIN WILK — Feb. 1930, pp. 498-503 (V. 26)

Developments in concrete products plants have brought to the front a question that seriously affects the design of concrete products plants for economical production. Shall a plant be designed for single or multiple shift operation? The author discusses the problem and concludes that the single shift plant is to be preferred over the multiple shift plant.

SOME TESTS OF CONCRETE MASONRY UNITS CURED WITH HIGH-PRESSURE STEAM 26-25

P. M. WOODWORTH — Feb. 1930, pp. 504-512 (V. 26)

The main purpose of this investigation was to obtain data concerning the effect of high-pressure steam curing on (1) early strength, (2) ultimate strength, and (3) strength as affected by time interval between molding and curing. The author believes that high-pressure steam curing has possibilities as a means for developing concrete products having high early strength and low shrinkage.

PRESIDENT'S ADDRESS 26-26

EDWARD D. BOYER — Mar. 1930, pp. 513-519 (V. 26)

The president's address at the 26th annual convention, concerning the advancement of concrete technology, its relationship to research and the relationship of both to the American Concrete Institute.

GOOD PRACTICE IN CONCRETE FLOOR FINISH 26-27

COMMITTEE 802 — Mar. 1930, pp. 520-532 (V. 26)

This report is the first effort of ACI's committee on floor finish to prepare a standard recommended practice in the placing of concrete floors.

THE DESIGN AND OPERATION OF CENTRAL MIXING PLANTS — A SYMPOSIUM 26-28

MILES N. CLAIR, H. F. THOMSON, N. D. CROWLEY, FRED C. WILCOX, and A. W. HUNSELL — Mar. 1930, pp. 551-579 (V. 26)

Comments on the design and operation of ready-mixed concrete plants

Author discusses briefly the problems of plant location, equipment, and plant operation.

Water control of a commercial central-mixing plant

To insure accuracy in admitting the predetermined quantity of mixing water to be added to a batch, there has been used successfully an enclosed, central syphon measuring tank equipped with a mechanical interconnection between inlet valve, outlet valve, and batch hopper gate, whereby the operator cannot admit more or less water than the quantity for which the measuring tank is set.

Notes from experience in mixing plant operation

Problems encountered in the operation of central mixing plants and the solutions at one plant are described. Storage of aggregate, conveyor systems for bulk cement, mixers, trucks, mix design, and control and peak loads are topics covered.

Recent developments and trends in the commercial concrete business

Central mixing plants, for the purpose of this study, 1928-1930, were classed as plants for producing commercial ready-mixed concrete. Growth of such plants quadrupled in that period; their annual production ranged from 3600 to 115,000 cu yd; and a total U. S. output of 5,000,000 cu yd of ready-mixed concrete valued at nearly $45,000,000 was indicated by the end of 1929. A strong trend was noted toward the "dry plant" system of central proportioning and mixing in transit, apparently based on sound operating practice and concrete control.

The use of central mixing plants by the Port of N. Y. Authority

Six central mixing plants and 11 batching plants used by the Port of New York Authority are described. In the operation of the plants the proportions to be used and the amount of water were fixed by the results of preliminary tests of the aggregates and cement used on each job. Test methods and specifications are described.

REINFORCED CONCRETE COLUMN INVESTIGATION 26-29

COMMITTEE 105 — Apr. 1930, pp. 601-612 (V. 26)

A list of the investigations on concrete columns with longitudinal or lateral reinforcement are given as well

as abstracts from some of these tests. Preliminary tests on the cement used in the ACI column investigation and strength data are reported.

THE COLORATION OF CONCRETE . . 26-30

RAYMOND WILSON — Apr. 1930, pp. 616-623 (V. 26)

Reviews the principal means of achieving chromatic effects and points out the precautions which experience and tests indicate as necessary in the use of each method. Concrete can be colored with pigments, aggregate, penetration processes, or paints. The choice of the basic method to be used is dependent on the requirements of color and finish, the type of service and exposure, and relative costs.

SHORE AND STORM PROTECTION ON THE GULF COAST 26-31

J. B. CONVERSE — Apr. 1930, pp. 626-636 (V. 26)

A review of conditions to be encountered on the Gulf Coast due to tropical hurricanes and the manner in which they have been met in building structures to prevent beach erosion and the flooding of populated areas.

SHRINKAGE MEASUREMENTS OF CONCRETE MASONRY 26-32

W. D. M. ALLAN — Apr. 1930, pp. 699-713 (V. 26)

A progress report of an investigation to ascertain rate and extent of volume change in concrete masonry walls as affected by moisture content of units at time of laying. The author reports shrinkage measurements on 24 panels of sand and gravel, cinder, and Haydite concrete masonry panels over 150 days. Wall shrinkage was greatly reduced by having units dry at time of laying. High-pressure steam curing also was effective in reducing shrinkage.

THE TREATMENT OF MONOLITHIC CONCRETE SURFACES 26-33

N. C. JOHNSON — May 1930, pp. 717-730 (V. 26)

Two general classifications of surfaces are: (1) form-cast surfaces of all kinds and (2) top surfaces, such as roadways and floors. The problems arising with form-cast surfaces are discussed and possible remedies are given. Surface treatments discussed include: wash and float work, bush hammering, machine grinding, acid treatments, painting, veneered surfaces, and chemical surfacings.

DEVELOPMENTS IN THE MANUFACTURE AND USE OF CONCRETE PIPE 26-34

M. W. LOVING — May 1930, pp. 732-747 (V. 26)

Paper is a general description of equipment and methods of the manufacture of concrete pipe. Concurrently, there is discussion of the wide use of the finished product. Two general classifications are included — reinforced and unreinforced. Importance of adequate mixing water is stressed and need for strict attention to mix and gradation of aggregates. Pipe must meet specifications and tests of ASTM. Reinforced concrete pipe is manufactured by three general processes: (1) the cast process, (2) machine, and (3) centrifugal. Reinforcement is either elliptical or circular and made up in spiral wound cages. Concrete pipe, because of its inherent strength and uniform quality, has come into wide use for water supply lines and irrigation purposes, as well as for sanitary and storm sewers and culverts.

FIRE DAMAGE TO AND REPAIR OF A CONCRETE FACTORY BUILDING . . . 26-35

JOHN G. AHLERS — May 1930, pp. 748-759 (V. 26)

A contractor's engineering report on repairs to a concrete building damaged by an intense concentrated fire. The damage to a section of the one floor necessitated removal of the floor above and the rebuilding of one section of the building. Construction methods used are described.

RECOMMENDED PRACTICES IN THE USE OF CAST STONE 26-36

COMMITTEE 704 — May 1930, pp. 760-765 (V. 26)

Cast stone should be composed of portland cement, durable aggregate, and unfading limeproof colors, manufactured in an enclosed factory or building, moist cured, and not delivered in less than 14 days. At 28 days it shall have a compressive strength of 5000 psi, not more than 7 percent nor less than 3 percent absorption, and be properly reinforced. Anchors and hoisting rings should be embedded in the stone.

MAKING AND PLACING CONCRETE REVETMENT MAT, VICKSBURG ENGINEER DISTRICT 26-37

MORRIS W. GILLAND — June 1930, pp. 799-830 (V. 26)

Results indicate that in all but special situations the concrete revetment mat is equal to and cheaper than the willow mat and can be made and placed more rapidly. Manufacture, equipment, and placing of the articulated type of reinforced concrete mat are described. The normal sequence of placing operations is clearing of the banks, grading, placement of subaqueous mat and upper bank paving. Upper bank paving consists of monolithic reinforced concrete, standard reinforced concrete mat sections, concrete blocks, or riprap stone.

COMPRESSIVE STRENGTH OF CONCRETE IN FLEXURE AS DETERMINED FROM TESTS OF REINFORCED BEAMS 26-38

WILLIS A. SLATER and INGE LYSE — June 1930, pp. 831-874 (V. 26)

An investigation was made to determine the relation between the compressive strength of 6 x 12-in. control cylinders and the strength of the same concrete computed from beam tests in which the concrete failed in compression. Compressive strengths of the concrete ranged from 1400 to 5800 psi.

The constant water content theory of proportioning concrete mixes was applied for the first time. The beam-cylinder strength ratio varied with the strength of the concrete. Using the straight line formula for computing stresses in the beams, the ratio varied from more than 2.0 to 1.4 while using the parabolic stress distribution it varied from 1.5 to 0.95 for concrete having a range in strength from 1400 to 5800 psi. The observed stresses in the steel agreed fairly well with the stresses computed by the straight line formula.

Proceedings V. 27

MEMORANDUM ON ARCH DAM DEVELOPMENTS 27-1

LARS JORGENSEN — Sept. 1930, pp. 1-64 (V. 27)

Records developments in arch dam design and construction with special reference to constant angle arch dam design. Actual cost data have been given for various structures — covering all kinds of locations — as a guide for estimating the cost of new work. When designing an arch dam, the simple arch formulas (unit water pressure $\times$ length of upstream radius $=$ unit stress $\times$ thickness) is used to obtain a preliminary section. The bending moments and resulting stresses are calculated by Cain's formulas. Design tables, equations, procedures, computations and drawings from various dams are included.

CONSTRUCTION SPECIFICATIONS FOR CONCRETE WORK ON THE SMALL JOB 27-2

ARTHUR R. LORD — Sept. 1930, pp. 65-97 (V. 27)

Superseded by 27-41

This proposed specification is unusual in conception and treatment. It may be read straight through on right-hand pages only, but is supplemented by "Specification Notes" appearing on left-hand pages and keyed to the specification. The notes explain and clarify the specification paragraphs by giving the reasons for recommending the practices therein.

CONSTRUCTION OF MAIN CANAL LINING ON KITTITAS DIVISION, YAKIMA RECLAMATION PROJECT, WASHINGTON 27-3

ARTHUR RUETTGERS and A. A. WHITMORE — Oct. 1930, pp. 117-150 (V. 27)

Deals with the construction of about 12 miles of 3-in. reinforced concrete canal lining of trapezoidal section, with an approximate bottom width of 12 ft, height of 11 ft, and side slopes of 1¼:1. A special feature of the construction was the first use of lining machines equipped with movable steel plates or metal-lined plank strike-off boards for placing the concrete monolithically in short panel sections. Data are given on various phases of the construction procedure, on the methods employed for controlling the quality of the concrete, and on the comparative results obtained with continuous sprinkling and black membrane curing.

CONSTRUCTION AND DESIGN FEATURES OF HAYDITE CONCRETE 27-4

F. E. RICHART and V. P. JENSEN — Oct. 1930, pp. 151-182 (V. 27)

Gives an analysis of test data previously reported by the authors on lightweight Haydite concrete of two types: (1) having Haydite coarse aggregate and natural sand as fine aggregate, (2) having Haydite fine and coarse aggregate. Application of the properties of these concretes is made to design and construction.

BLAST FURNACE SLAG AS CONCRETE AGGREGATE 27-5

COMMITTEE 201 — Oct. 1930, pp. 183-219 (V. 27)

Deals briefly with all characteristics of blast furnace slag for use as concrete aggregate, together with many references giving laboratory and field results obtained by the use of slag concrete. The report includes a bibliography giving about 60 references to publications, committee reports, and other data pertaining to the use of blast furnace slag as concrete aggregate with quotations from 37 authors.

ARCHITECTURAL CONCRETE — FORMS, MOLDS AND SURFACES 27-6

WILLIAM C. WAGNER — Nov. 1930, pp. 225-241 (V. 27)

In building forms for architectural concrete there is no radical departure from the practice accepted for structural concrete, unless it be that they are lined with materials that control the character of the resultant surface. In a broad sense there are three types of wall treatment encountered in buildings — plain, ornamented, and molded surfaces — each of which requires a different type of form lining. The article describes lined forms for plain surfaces, wood forms, plaster molds, oiling forms and molds, architectural concrete mixtures, placing operations, form stripping, and patching and curing.

DESIGN AND CONSTRUCTION OF BONNET CARRE SPILLWAY 27-7

HELMER SWENHOLT — Nov. 1930, pp. 243-262 (V. 27)

The Bonnet Carre spillway is a controlled spillway 7700 ft long on the Mississippi River, emptying in time of unusual flood through a leveed floodway into Lake Pontchartrain. It is capable of discharging 250,000 sec ft. The structure rests on an alluvial soil and its operation covers all conditions of flow and backwater from no flow to full capacity. Design and construction details are described.

COMPOSITE COLUMNS 27-8

L. J. MENSCH — Nov. 1930, pp. 263-280 (V. 27)

Composite columns are hooped concrete columns with standard spiral and vertical reinforcing and with an additional heavy strengthening member of cast iron or structural steel.

Paper describes in detail tests on 14 composite columns at the Talbot Laboratory of the University of Illinois which showed that the then existing and also the present code requirements were too restricted.

Also describes and lists the tests on a large number of composite columns made at the National Bureau of Standards, the Armour Institute of Technology, the Lewis Institute of Chicago, by Emperger, and a number of European universities.

Result of the tests at the University of Illinois was briefly as follows: columns failed at an average stress on the concrete section with 1 percent of spiral hooping and stresses in the cast iron core from 38,500 to 44,900 psi and stresses in steel cores of from 34,400 to 36,800 psi.

SPECIFICATIONS FOR READY-MIXED CONCRETE 27-9

MILES N. CLAIR — Nov. 1930, pp. 281-288 (V. 27)

Superseded by 27-39

These specifications cover the special conditions affecting the use of ready-mixed concrete and can be used as a supplement to any general specification for plain and reinforced concrete.

STRENGTH AND SHRINKAGE OF MORTARS MADE WITH BLENDS OF PORTLAND CEMENT AND POZZOLANIC MATERIALS 27-10

C. A. HUGHES and A. S. LEVENS — Dec. 1930, pp. 317-337 (V. 27)

The tests for which the data are presented were undertaken to determine the effect of four pozzolanic materials, two types of volcanic ash, blast furnace slag, and burnt shale, on the strength and shrinkage of mortars. The compressive strengths of mortars made with the blended cements were less at early ages than those of portland cement mortars but at 90 days and greater, with continued moist curing, higher strengths were obtained. During initial drying, shrinkage of blended mortars was greater than that of the portland cement mortars.

TESTS OF BONDING FLOOR FINISH TO SLABS OF HAYDITE AND GRAVEL CONCRETE 27-11

F. E. RICHART and V. P. JENSEN — Dec. 1930, pp. 339-349 (V. 27)

Tests are reported for 12 small reinforced concrete slabs, consisting of a 5-in. base course and ¾-in. finish, tested in flexure on a 4-ft span with third-point loading so as to produce a relatively high horizontal shear. The Haydite base courses were found to be bonded to the floor finish as effectively as those of gravel concrete.

DEFLECTION OF REINFORCED CONCRETE MEMBERS 27-12

T. D. MYLREA — Dec. 1930, pp. 351-357 (V. 27)

From a study of deflection formulas the conclusions are reached that (1) deflections of members are not a sensitive index of the quality of concrete; (2) this fact makes such formulas of value in computing camber, and (3) gives confidence in computations involving continuity.

CONTINUOUS BEAMS AND FRAMES IN BUILDING CONSTRUCTION 27-13

U. T. BERG — Dec. 1930, pp. 359-376 (V. 27)

Tables and charts are presented for the determination of maximum bending moments and shears in continuous beams and rigid building frames of approximately equal spans. The loading on the individual span may be any symmetrical load or group of loads. The various unfavorable conditions of loading are considered. An appendix describes the fixed point method.

Author's correction — Apr. 1931.

PROPERTIES OF MASS CONCRETE . . 27-14

RAYMOND E. DAVIS and G. E. TROXELL — Jan. 1931, pp. 385-418 (V. 27)

This paper was written at the beginning of the present era of general interest in mass concrete. It discusses the factors causing temperature rise, summarizes the available data on maximum temperatures observed in a number of dams and other massive

structures, gives the results of tests in several laboratories to determine temperature rise and its effect on strength, and proposes an experimental program. Bibliography of 23 items is included.

A STUDY OF THE FLOW-TABLE AND THE SLUMP TEST 27-15

GEORGE A. SMITH and SANFORD W. BENHAM — Jan. 1931, pp. 420-438 (V. 27)

The tests with which this paper deals were made to determine the necessary flows to be used to give definite slumps so that more careful measurement of workability of concretes could be made using the flow-table instead of the slump test. The results indicate that the flow test is more sensitive than the slump test in differentiating between changes in the workability of concrete with changes in the quantity of water used.

A STUDY OF SLUMP AND FLOW OF CONCRETE 27-16

INGE LYSE and W. R. JOHNSON — Jan. 1931, pp. 439-467 (V. 27)

An investigation of the relationship between the slump and flow of concrete showed that the slump gave a more suitable indication than the flow of the increased workability of concrete produced either by enriching the mix or additions of admixtures. The relation between the flow and the slump changed with the richness of the concrete mix.

CURRENT RESEARCHES ON PLAIN AND REINFORCED CONCRETE AND RELATED MATERIALS 27-17

COMMITTEE 101 — Jan. 1931, pp. 469-510 (V. 27)

A compilation of current researches conducted by various college, government, and commercial laboratories throughout the country arranged according to the following subjects: cement, plain concrete; reinforced concrete; and suggested researches on concrete and related subjects.

Since many of the researches listed had not been completed, the test results were not generally available at the time the committee report was presented.

DESIGN AND CONTROL OF CONCRETE FOR DIABLO DAM 27-18

H. F. FAULKNER and R. R. HUBBARD — Feb. 1931, pp. 529-545 (V. 27)

Diablo Dam is the second major unit to be completed in the comprehensive development to furnish hydroelectric power for the city of Seattle.

The concrete was designed and specified with particular recognition that the hydrostatic pressures would be great, that permeability is in direct ratio to pressure, that any dissolving of the cement by percolating water is proportional to the quantity of percolating water, that it was necessary to obtain concrete of low permeability, and that the arch type of dam, of relatively thin section, logically requires a stronger, more nearly impermeable concrete than does one of gravity section.

SOME LONG-TIME TESTS OF CONCRETE 27-19

M. O. WITHEY — Feb. 1931, pp. 547-582 (V. 27)

Crushing strength-age relationships for several mixes of concrete made with different aggregates cured outdoors, under water, and in air indoors feature this report. Over 2000 concrete cylinders, also many auxiliary mortar specimens for strength-age determinations and absorption, freezing and thawing, and expansion tests are included. Analysis of cements are listed. For the outdoor and underwater curing conditions the strength of the concrete increased approximately as the logarithm of the test age up to 20 years, for the indoor storage no increase in concrete strength occurred after 3 months.

CINDERS AS CONCRETE AGGREGATE 27-20

EINAR CHRISTENSEN — Feb. 1931, pp. 583-646 (V. 27)

A summary of the field of cinder aggregates, from the nature and properties of cinders to the characteristics of the resulting concrete. The topics covered include: properties of cinder aggregates, specification for cinders, cinder concrete building units, sand-cinder concrete, and properties of cinder and sand-cinder concrete.

ADMIXTURES AND WORKABILITY OF CONCRETE 27-21

G. M. WILLIAMS — Feb. 1931, pp. 647-653 (V. 27)

Segregation in concrete may be due to a too fluid mortar to a relatively small volume of mortar or both. Powdered admixtures tend to reduce segregation by increasing the volume of mortar as well as furnishing a less fluid mortar for any required flowability. Relative volume of paste obtained per unit weight of admixture, with flowabilities the same, is a measure of admixture efficiency.

A COMPARISON OF CONTINUOUS WITH BATCH MIXERS IN PLANT OPERATION 27-22

BENJAMIN WILK — Feb. 1931, pp. 655-659 (V. 27)

Test results indicate that the variation between the strength of block made from the continuous mixer of the long trough type and the usual batch mixer is small, although the time of mixing in the continuous mixer is approximately 1 min as against 6 min in the batch mixer.

REINFORCED CONCRETE COLUMN INVESTIGATION 27-23

COMMITTEE 105 — Feb. 1931, pp. 675-676 (V. 27)

Second progress report of Committee 105. An introduction to the column investigation reports from Lehigh University and the University of Illinois.

FIRST PROGRESS REPORT ON COLUMN TESTS AT LEHIGH UNIVERSITY 27-24

W. A. SLATER and INGE LYSE — Feb. 1931, pp. 677-730 (V. 27)

Presentation is made of the result of Series 1 and 2 of the ACI column investigations at Lehigh University. Series 1 was a study of the end conditions of the columns and Series 2 of whether the holding of load for a short period would have any effect on the strain and ultimate strength of the column. The result showed that the end conditions had a marked effect on the strength of the column. The strains measured on the steel agreed well with those on the concrete. The average strength of the plain columns was approximately 85 percent of the strength of the cylinders. The strength of plain columns tested with slow loading was slightly less than that with fast loading. For reinforced concrete the difference in strength due to method of loading was small. The longitudinal reinforcement contributed to the strength of the column an amount equal to the total yield point strength of the reinforcement. The spiral added a strength to the column equal to about 70 percent of the strength added by an equal amount of longitudinal steel of same grade as the spiral.

PROGRESS REPORT ON COLUMN TESTS AT THE UNIVERSITY OF ILLINOIS. . . 27-25

F. E. RICHART and G. C. STAEHLE — Feb. 1931, pp. 731-760 (V. 27)

This is the first of four progress reports on the column tests at the University of Illinois. The report records data on the materials used in all of the tests, and gives the results of test Series 1 and 2. Series 1 covered studies of end details of columns: (1) plane ends, with milled ends of bars flush with concrete, (2) an enlarged capital at each end of column, with bars stopped 3 in. from ends, (3) plane ends with dowels flush with ends and 20 diameter lap splices, and (4) like (3) but with 30 diameter laps. These tests showed the best results with type (1) and it was used in all later tests. Series 2 covered tests of columns under "rapid" and "slow" loading, with a large variety of grades and amounts of longitudinal steel and four grades of concrete.

SECOND PROGRESS REPORT ON COLUMN TESTS AT THE UNIVERSITY OF ILLINOIS 27-26

F. E. RICHART and G. C. STAEHLE — Mar. 1931, pp. 761-790 (V. 27)

This report of Series 3 of the investigation covers tests of 153 columns used to study the effect of sustained loading for a year or more. The sustained load was applied by coiled car springs. Strain measurements were taken on both loaded and unloaded columns to separate the effects of shrinkage and creep. The greatest steel stress reported, after 5 months' loading, was 27,100 psi, an increase of 11,600 psi over the stress at initial loading. The increase in stress due to creep was greatest for the columns with the least longitudinal reinforcement.

SECOND PROGRESS REPORT ON COLUMN TESTS MADE AT LEHIGH UNIVERSITY 27-27

W. A. SLATER and INGE LYSE — Mar. 1931, pp. 791-835 (V. 27)

Results of Series 3 of the ACI column investigation are presented. This series was for the purpose of studying the effect of sustained working load on the deformation and strength of the columns.

Twenty weeks of sustained loading is reported. The stress in the steel increased and that in the concrete decreased during the sustained loading. The decrease in stress in the concrete was greater for columns with large amounts of longitudinal reinforcement than for those with small amounts. Strengths of columns are not given in this paper.

FLOW OF CONCRETE UNDER THE ACTION OF SUSTAINED LOADS . . . 27-28

RAYMOND E. DAVIS and HARMER E. DAVIS — Mar. 1931, pp. 837-901 (V. 27)

Authors present results of tests on plain and reinforced concrete to determine the effect of sustained load on magnitude of plastic flow in plain concrete and on distribution of stresses in steel and concrete in reinforced columns. Part I describes laboratory tests on about 200 cylindrical specimens, loaded in compression, some over a period of about 3 years, to determine the effect of intensity of stress, age at time of loading, character of mineral aggregate, gradation of aggregate, cement content, water-cement ratio, reinforcement, cyclic application of load, and moisture conditions of storage. Part II summarizes published results of other investigations during the previous 25 years.

BASIS OF DESIGN FOR HURRICANE EXPOSURE 27-29

ALBERT SMITH — Mar. 1931, pp. 903-924 (V. 27)

Any structure must be regarded as a whole in computing its wind stresses; when the building is unsymmetrical in any respect and is of great height, the labor of making the closest practicable approximation to the true stresses is not only justified, it is essential.

Author gives a basis of design for high wind forces and presents an example computation as well as several charts to facilitate design procedure.

ECONOMICS OF LIGHTWEIGHT CONCRETE IN BUILDINGS 27-30

FRANK A. RANDALL — Mar. 1931, pp. 925-943 (V. 27)

Comparisons of the costs of the structural frame and foundations are made for the following conditions:

Five weights of concrete — 50, 75, 100, 125, and 150 lb per cu ft; two types of floor construction — 4 in. solid slabs and 20 in. steel form joists; reinforced concrete and structural steel frames; six heights of building — 5, 10, 15, 20, 25, and 30 stories, with basements; spread footings for 5- and 10-story buildings, wood piles for 15- and 20-story buildings, and hard pan caissons for 25- and 30-story buildings; and unit costs of 30, 40, and 50 cents per cu ft in place for superstructure concrete. Quantities and costs are computed for all combinations of the above variables.

Costs per cubic foot of building are shown in graphs and tables and deductions are drawn as to the effect on costs of increases in height, as to the effect of the weight of concrete used, and as to the comparison of the costs of concrete and steel frames.

THE AMERICAN CONCRETE INSTITUTE AND CONCRETE RESEARCH 27-31

DUFF A. ABRAMS — Apr. 1931, pp. 953-957 (V. 27)

Retiring President Abrams emphasizes the importance of research activities and discusses the relationship of research with Institute activities. He states that research is the handmaiden of design and construction, but is of no value until it is translated into office and field usage.

STUDIES OF CONCRETE MIXTURES . . 27-32

S. C. HOLLISTER — Apr. 1931, pp. 959-974 (V. 27)

In the course of concrete mixing and placing, it has been the experience of many that there are occurrences in the behavior of the mixture that are not readily explained by the customary concepts of mixtures. Paper relates and attempts to explain many of the phenomena through the medium of a more detailed concept of the concrete mixture prior to hardening.

THE USE OF COLOR IN CONCRETE . . 27-33

COMMITTEE 408 — Apr. 1931, pp. 975-990 (V. 27)

A progress report of ACI Committee 408 presenting a recommended practice covering the use of pigment admixtures for producing colored concrete. A practical discussion is included on selecting materials, proportioning, placing, finishing, curing, cleaning, removing efflorescence, and other details essential to a first-class job.

PROPOSED RECOMMENDED PRACTICE FOR THE MANUFACTURE OF CONCRETE BUILDING BLOCK AND TILE 27-34

P. M. WOODWORTH — Apr. 1931, pp. 1001-1020 (V. 27)

These recommendations are intended to aid manufacturers of concrete building block and tile to make products that meet standard specifications of the American Concrete Institute and to produce them economically. In addition to recent developments in the manufacturing procedure and in the use of porous aggregates, considerable attention is given to plant layout. This recommended practice is intended particularly for plants with an average daily production of 500 or more units, but much of the material will be of value for smaller units.

DURABILITY OF CONCRETE 27-35

COMMITTEE 801 — May 1931, pp. 1037-1038 (V. 27)

Report of Committee 801 introducing two papers — "Study of Defective Concrete," by F. R. McMillan and "More Lessons from Concrete Structures in Service," by R. B. Young.

STUDY OF DEFECTIVE CONCRETE . . . 27-36

F. R. McMILLAN — May 1931, pp. 1039-1064 (V. 27)

A survey of concrete structures representative of many types of aggregates, methods of construction and conditions of exposure in the United States and Canada. Types of defective concrete are illustrated and the causes traced to such factors as mix, consistency, soundness of aggregates, quantity of cement, and other faulty construction practices.

MORE LESSONS FROM CONCRETE STRUCTURES IN SERVICE 27-37

RODERICK B. YOUNG — May 1931, pp. 1065-1090 (V. 27)

The Hydro-Electric Power Commission of Ontario decided, some years ago, to systematically study the behavior of their many concrete structures, with a view to learning not only their existing condition, but their probable condition in years to come. The examinations were extended to include other concrete structures in different parts of Canada and the United States, until the number of inspections now made have reached a

total of several hundred. This paper is an attempt to set down briefly some of the conclusions that have been reached as a result of these examinations.

THE PERMEABILITY OF GRAVEL CONCRETE 27-38

PAUL T. NORTON, JR. and DAN H. PLETTA — May 1931, pp. 1093-1132 (V. 27)

Thirty-four different mixes, each with four different water contents, were used as batches for absorption, compression, and permeability specimens. The series was repeated five times and about 2000 cylinders were tested. Permeability was determined by measuring the water forced into the concrete under 40 and 100 psi pressure.

Results indicated: (1) a 2 to 4 in. slump range for minimum permeability, (2) a decrease in permeability with increase in strength and cement-voids ratio, (3) no improvement with age after curing ceases and (4) no correlation between permeability and absorption.

TENTATIVE SPECIFICATION FOR READY-MIXED CONCRETE (504-31-T) . 27-39

COMMITTEE 504 — May 1931, pp. 1173-1180 (V. 27)

Supersedes 27-9

Proposed by Committee 504, ACI Journal, November, 1930, Proc. V. 28, p. 281, and now published with amendments adopted by the 27th annual convention, February, 1931.

TENTATIVE CONSTRUCTION SPECIFICATION FOR CONCRETE WORK ON ORDINARY BUILDINGS (502-31-T) 27-40

COMMITTEE 502 — May 1931, pp. 1181-1183 (V. 27)

Supersedes 26-1

The report of Committee 502 was published in the ACI Journal, November, 1929, Proc. V. 26, p. 1. Discussions (Mar. 1930, Proc. V. 26, p. 580) prompted the committee to make several revisions and the specification was tentatively adopted by the Institute as 502-30-T at the 26th annual convention, 1930. The section on admixtures was amended and tentative specification 502-31-T was adopted at the 27th annual convention, February, 1931.

TENTATIVE CONSTRUCTION SPECIFICATION FOR CONCRETE WORK ON THE SMALL JOB (506-31-T) 27-41

COMMITTEE 506 — May 1931, pp. 1184-1185 (V. 27)

Supersedes 27-2

Committee 506 proposed at the 27th annual convention, February, 1931, amendments to Articles 4 and 10 of "Proposed Construction Specification for Concrete Work on the Small Job," first published in the Journal, September, 1930, Proc. V. 27, p. 65. The amendments were accepted and as thus amended, the specification was tentatively adopted.

TENTATIVE SPECIFICATION FOR SUPPLYING, FABRICATING AND SETTING REINFORCING STEEL ON ORDINARY BUILDINGS (503-31-T) . . . 27-42

COMMITTEE 503 — May 1931, p. 1186 (V. 27)

Supersedes 26-20

The report of this committee published in the Journal, February, 1930, Proc. V. 26, p. 444; formally presented at the 26th annual convention, February, 1930, was presented to the 27th annual convention, February, 1931, for adoption as a tentative specification.

CONCRETING THE CALDERWOOD TUNNEL 27-43

W. R. JOHNSON — June 1931, pp. 1189-1202 (V. 27)

The Calderwood Tunnel is part of the hydroelectric development of the same name built by the Aluminum Co. of America on the Little Tennessee River. The tunnel is 2400 ft long, approximately 26 ft in diameter inside the 12-in. concrete lining, and forms the connection between the dam and powerhouse.

The excavation from the tunnel, a dense arkose, was used as a portion of the concrete aggregate. The tunnel was concrete lined in three stages: curb, arch, and invert. A total of 28,000 cu yd of concrete was required for the lining. The coarse aggregate was graded from ¾ to 3 in. and the sand from 0 to No. 4. The coarse aggregate was produced by crushing the arkose obtained from the quarry and tunnel excavation. The fine aggregate was obtained by passing the ¾-in. sizes through two sets of roll crushers.

Concrete was brought to the tunnel in 2-cu yd buckets and then dumped into hoppers mounted on flat cars. The cars were pulled into the tunnel by a gas-electric locomotive and the concrete then discharged into two pneumatic concrete placers which in turn forced the concrete by air into and through an 8-in. discharge pipe to its final place of deposit in the form. A collapsible Blaw-Knox steel form was used. A 30-ft section was placed every 24 hr. The discharge pipe bends were made of Hagen-White iron to obtain longer wear. Form vibrators were used for consolidating the concrete.

Sequence of mixing, transporting and placing was of vital importance as any delay causing a stiffening of the concrete made it difficult to handle.

FIELD PRACTICES IN USING CONCRETE AGGREGATES IN MULTIPLE SIZES . . 27-44

T. C. THEE — June 1931, pp. 1203-1227 (V. 27)

Field practices using multiple sizes of aggregate in paving operations are cited. This separation of sizes helps eliminate segregation in transportation and stock piling. Cost and time study data are given for two- and three-way batching used in paving operations as well as plant layouts for the handling of multiple size aggregates.

DESIGN AND OPERATION OF CENTRAL MIXING PLANTS 27-45

FRANK I. GINSBERG — June 1931, pp. 1237-1249 (V. 27)

Outlines the progress in central plant design and operation. The conditions that govern the design and arrangement of ready-mixed concrete plants are controlled by a number of local factors. The items covered include: types of plants, equipment, methods, handling of bulk cement, and types of trucks used for delivery.

SPECIFICATION FOR CONCRETE BURIAL VAULTS 27-46

COMMITTEE 709 — June 1931, pp. 1251-1260 (V. 27)

Superseded by 28-34

A progress report of ACI Committee 709 submitting a suggested specification for concrete burial vaults. Changes were incorporated in the specifications and resubmitted by the committee at the 29th annual convention, March, 1932, at which time the proposed specification was adopted. See ACI Journal, May 1932, Proc. V. 28, p. 633.

Proceedings V. 28

THE EFFECT OF ACID WATERS ON CONCRETE 28-1

BAILEY TREMPER — Sept. 1931, pp. 1-32 (V. 28)

A report of laboratory and field investigations on attack by slightly acid waters flowing past but not through the body of concrete structures with particular reference to pipes. Laws are developed which relate quality of concrete, strength of acid, loss of lime, length of exposure, and surface-volume ratio of the structure with extent of attack.

TESTING CAST STONE 28-2

COMMITTEE 704 — Sept. 1931, pp. 33-36 (V. 28)

Committee 704 reports on its test program concerning testing procedures and strength and density requirements as covered by the Tentative Specification for Cast Stone (P3-A-29T) and recommends several changes in the specification.

THE USE OF CEMENT IN BULK 28-3
HERBERT COFFMAN — Sept. 1931, pp. 37-58 (V. 28)
An illustrated description of the various methods of handling cement in bulk both at the factory and on the job. The report also shows the different means of transportation and the unloading systems. The economic advantages are listed.

DETERMINING CHARACTERISTICS OF CONCRETE IN THE MIXER DRUM. . . . 28-4
EMORY D. ROBERTS — Sept. 1931, pp. 59-72 (V. 28)
Based on preliminary investigations on measuring workability of concrete during mixing, a mechanism, called a consistency indicator, was designed and operated in conjunction with regular paving operations to determine whether such an apparatus would have practical application. The consistency meter was designed to indicate the relative pressures exerted on a bar by the concrete as it was being mixed in the mixer drum. An oil gage, registering pressures from 0 to 30 lb, gave an index of the pressure on the bar. The conclusions reached were that the indicator would provide a means of securing greater uniformity in concrete both as to workability and quality.

UNUSUAL FEATURES IN DESIGN AND CONSTRUCTION OF A 20-MILLION GALLON CONCRETE RESERVOIR 28-5
ARTHUR B. MORRILL — Oct. 1931, pp. 81-95 (V. 28)
Describes the design and construction of a 20-million gallon concrete reservoir for the city of Detroit. The hydraulic arrangements of the filtration plant required that the reservoir be almost entirely below the natural ground surface. The roof was designed to carry ordinary highway loads and roadways and walks were constructed across the roof. Details described include excavation, pile foundations, concrete design and mixtures, form ties, and waterproofing.

CONCRETE PLANT ON DETROIT WATER FILTRATION SUBSTRUCTURE 28-6
W. K. SAUNDERS — Oct. 1931, pp. 97-108 (V. 28)
To handle and deposit approximately 75,000 cu yd of concrete over an area about 600 sq ft, several methods of placing were considered. Belt conveyors offered a flexible system and were used successfully.

THE MODIFIED SLOPE-DEFLECTION EQUATION 28-7
L. T. EVANS — Oct. 1931, pp. 109-130 (V. 28)
Presents a general form of the slope-deflection equation that applies to members of any moment of inertia variation. Equations for elastic constants and fixed-end moments are derived for the general beam or column as well as for specific cases.
The method of computing the "equivalent haunch" of both the beam and the column at their intersection is also treated. A numerical example illustrates the importance of investigating the influence of the moment of inertia variation on the bending moments.
A comprehensive series of design charts gives all constants necessary to design haunched members.

REINFORCED CONCRETE COLUMN INVESTIGATION 28-8
COMMITTEE 105 — Nov. 1931, pp. 157-158 (V. 28)
The third progress report of Committee 105 introduces the reports from Lehigh University and the University of Illinois on Series 7 in the column investigation program.

THIRD PROGRESS REPORT ON COLUMN TESTS AT LEHIGH UNIVERSITY 28-9
WILLIS A. SLATER and INGE LYSE — Nov. 1931, pp. 159-166 (V. 28)
Results of Series 7 of the ACI column investigation are reported. This series included tests on the effect of amount and grade of spiral reinforcement on strength of columns. Within the range of the strains measured, variation in the amount or grade of spiral had practically no effect on the deformation of the columns. For "fast" loading, the strength added by the spiral was about equal to the strength added by an equal amount of longitudinal reinforcement of the same yield-point stress.

THIRD PROGRESS REPORT ON COLUMN TESTS MADE AT THE UNIVERSITY OF ILLINOIS 28-10
F. E. RICHART and G. C. STAEHLE — Nov. 1931, pp. 167-175 (V. 28)
This report covered tests of Series 7 of the column investigation, in which a comparison was made between drawn wire and hot rolled rod for spirals. The margin of strength produced by the spirals was found to be closely proportional to the yield point or "useful limit" of the two grades of steel.

SHRINKAGE MEASUREMENTS OF CONCRETE BLOCK MASONRY 28-11
W. D. M. ALLAN — Nov. 1931, pp. 177-185 (V. 28)
The final report of a study to determine nature and extent of volume change in concrete masonry walls as affected by moisture content of the units at the time they are laid and also to determine the effect of wetting the wall subsequent to drying. Purpose of the study was to find a way to reduce or eliminate volume change and shrinkage. Measurements were taken on 38 panels of concrete masonry built with block of different ages (sand and gravel, Haydite, cinders, granulated slag, and crushed limestone aggregates). The volume change was greatly reduced by using air-dry units. High-pressure steam curing also minimized shrinkage.

BOND, SHEAR AND DIAGONAL TENSION IN REINFORCED CONCRETE 28-12
J. R. SHANK — Nov. 1931, pp. 187-192 (V. 28)
Rational theories and expressions for bond, shear, and diagonal tension are developed from the theory usually given in treatises in mechanics for horizontal shear. By this procedure the expression for bond is nearest the fundamental. From this come horizontal and vertical shear and their vector sum which is diagonal tension. This leads directly to the general expression (17) of 804, (d) of the ACI Building Code (ACI 501-36-T).

TESTS OF INTEGRAL AND SURFACE WATERPROOFINGS FOR CONCRETE. 28-13
C. H. JUMPER — Dec. 1931, pp. 209-242 (V. 28)
This is a report of the study of integral and surface waterproofing materials for concrete. Fifty integral waterproofing materials were incorporated into a 1:3:6 concrete and subjected to a water pressure of 20 psi for 1 year and their permeability noted in comparison to plain concrete. Detailed discussion is given of the effect of each material on concrete.
Fifty surface waterproofing materials were applied to concrete cylinders and absorption figures obtained. Results were compared with ones obtained on uncoated concrete. A general resume is given.

THE PHYSICAL PROPERTIES OF CAST STONE 28-14
JOHN TUCKER, JR., G. W. WALKER, and J. ARTHUR SWENSON — Dec. 1931, pp. 243-264 (V. 28)
A report of results of tests made as basis from which the Federal Specification for Cast Stone was prepared. The 68 samples were representative of all the usual methods of fabrication and included a wide variety of aggregate. The strengths, absorption properties, and resistance to freezing and thawing were determined. The compressive strengths varied from 1550 to 21,720 psi, the 48-hr absorption from 2.0 to 13.1 percent. The resistance to freezing and thawing varied from complete disintegration at 25 cycles to the first signs of disintegration at 1450 cycles.

FOURTH PROGRESS REPORT ON THE COLUMN TESTS MADE AT THE UNIVERSITY OF ILLINOIS 28-15

F. E. RICHART and G. C. STAEHLE — Jan. 1932, pp. 279-315 (V. 28)

A summary of test results of Series 3, 5, and 6. Series 3 covered tests of 153 columns subjected to sustained loading or used as shrinkage specimens. After 1 year of observation most of these columns were tested to failure in axial compression. The initial stresses produced by creep and shrinkage evidently produced no effect on the ultimate strength of the columns.

Series 5 and 6 consisted of tests of columns having core diameters of 8, 12, 20, and 28 in., all columns being 7½ core diameters in height. Those of Series 6 had 2-in. protective shells. The largest columns were 32 in. in diameter, 17.5 ft high.

FOURTH PROGRESS REPORT ON COLUMN TESTS AT LEHIGH UNIVERSITY 28-16

INGE LYSE and C. L. KREIDLER — Jan. 1932, pp. 317-346 (V. 28)

This is a second report on Series 3 of the ACI column investigation and includes the results of columns maintained 52 weeks under sustained loading and then loaded to failure. It was found that the rate of flow was greatest for the smallest and least for the largest percentage of longitudinal reinforcement. The flow was much greater when the columns were stored dry than when they were stored wet. The strength of the columns which had been subjected to working loads 52 weeks was essentially the same as the strength of their companion columns which had not been previously loaded. The ultimate strength of reinforced concrete columns may be considered equal to: (a) 75 percent of the cylinder strength of the concrete times the concrete area, (b) the total yield-point strength of the longitudinal reinforcement, and in case of spiral reinforcement, (c) the total yield-point strength of the spiral reinforcement times its effectiveness ratio.

PROPERTIES AND PROBLEMS OF MASONRY CEMENTS 28-17

J. C. PEARSON — Feb. 1932, pp. 349-361 (V. 28)

Great diversity in the characteristics of masonry cements and lack of adequate specifications for them suggested a questionnaire as to what properties of these cements are most important in service. Answers yielded the following order: (1) plasticity; (2) volume change; (3) weather resistance; (4) adhesion; (5) elasticity; (6) rate of stiffening; (7) efflorescence; (8) impermeability; (9) strength; (10) staining. Author discusses possibility of tests for these properties in the light of his own test data and the opinions of others.

THE STRUCTURAL PERFORMANCE OF CONCRETE MASONRY WALLS 28-18

F. E. RICHART — Feb. 1932, pp. 363-385 (V. 28)

Test results from about 70 large concrete masonry wall panels, 6 x 9½ ft. and 50 wallettes, 2⅔ x 4 ft, of 29 types. The variables studied included: type of aggregate, design of units, strength of units, type of mortar and mortar joints, wall thickness, action of composite walls of brick and concrete units, axial and eccentric loading. The paper discusses test results, code requirements, and general performance of masonry walls in building construction.

DEFLECTIONS AND VIBRATIONS IN HIGH BUILDINGS 28-19

L. J. MENSCH — Feb. 1932, pp. 387-404 (V. 28)

By the moment area principle, simple formulas are derived for the analysis of windbracing systems which enable engineers to design tall building frames in a surprisingly short time. Simple formulas are also given for windbracing systems with great variation of column and girder sizes, spans, and story heights.

By the same method formulas are derived for the shear deflections of windbracing skeletons and for the deflections due to longitudinal stresses. Simple formulas are also derived for the vibrations of tall buildings due to the gustiness of the wind, based on the proved formulas of the pendulum and the tuning fork.

TESTS OF CONCRETE FROM A TRANSIT MIXER 28-20

S. C. HOLLISTER — Feb. 1932, pp. 405-417 (V. 28)

Reports the tests of a variety of concrete mixes made in 1-, 2½- and 4-cu yd Jaeger truck-transit mixers, the mixing time in some cases extending to 90 min. The purposes of the tests were (1) to determine the relation between the strength of the concrete and the time of mix, (2) the relation of time of mix to the degree of uniformity of the concrete produced, and (3) the relation of other observable features of the mixing operations to both strength and uniformity of output.

STUDIES OF WORKABILITY OF CONCRETE 28-21

T. C. POWERS — Feb. 1932, pp. 419-448 (V. 28)

This study is based on a remolding test which measures the relative effort required to change a mass of fresh concrete from one definite shape to another by jigging. It was found that workability depends on three major factors: (1) proportion of cement-water paste, including admixtures, if any; (2) consistency of the paste; (3) gradation and type of aggregate. A wide range in coarse aggregate gradations can be used with equal cement economy, provided that with each gradation the optimum percentage of sand and pea-gravel is used.

PROPOSED SPECIFICATIONS FOR CONCRETE PAVEMENT IN MUNICIPALITIES 28-22

COMMITTEE 902 — Mar. 1932, pp. 453-478 (V. 28)

These specifications have been written to apply to average conditions in municipalities. Principles of design, alternates, and explanations are given in the appendix. By studying the appendix, engineers should be able to make alterations to fit local conditions and thus obtain a more economical pavement or provide for unusual traffic or subgrade conditions. Specifications include: preparation of roadway, materials, joints, forms, proportioning, mixing, depositing concrete, finishing, curing and protection, and appendix.

PLAIN AND REINFORCED CONCRETE ARCHES 28-23

CHARLES S. WHITNEY — Mar. 1932, pp. 479-519 (V. 28)

A progress report on the limitations of the theory of elasticity and the effect on stresses in an arch rib of plastic flow, shrinkage, temperature variations, and the Freyssinet method of adjustment. The development of the theory of stress release due to plastic flow is included.

DESIGNING CONCRETE FOR WEIGHT OF 271 POUNDS PER CUBIC FOOT 28-24

C. C. KEYSER — Apr. 1932, pp. 525-529 (V. 28)

For the construction of the counterweights of the bascule span of the Arlington Memorial Bridge, Washington, D.C., it was necessary to design a concrete having a weight of 271 lb per cu ft, not less than 6 bags of cement per cu yd and a compressive strength of at least 2000 psi. Tests indicated that Swedish iron ore combined with steel punchings gave the most satisfactory and economical heavy aggregate. The tests indicated that from a knowledge of the specific gravity of the ingredients used it is possible to compute the weight of fresh concrete to within about 1 percent.

NOTES ON HARDENING CEMENTS AT THE BOILING POINT OF WATER....28-25

P. H. BATES and R. L. BLAINE — Apr. 1932, pp. 531-535 (V. 28)

Plastic mortars of four different cements were prepared and subjected to boiling water and steam at atmospheric pressures for 16 hr within ½ hr after molding. The results so obtained when compared with the results secured in testing the same mortars cured in a

damp closet at 70 F show that the higher temperatures materially increase the strength at 24 hr, but at 7 and 28 days there is little or no difference. The different cements do not react to the same degree at the higher temperatures.

STUDIES OF HIGH-PRESSURE STEAM CURING 28-26

J. C. PEARSON and E. M. BRICKETT — Apr. 1932, pp. 537-550 (V. 28)

An exploratory investigation of factors affecting strength of concrete containing siliceous aggregate and cured in high-pressure steam. Tests were made at gage pressures from 68 to 200 psi and for curing times from 12 to 66 hr. Longer curing at lower pressures and shorter curing at higher pressures gave similar results. Strengths were in general higher from 18-hr curing at 150 psi than from 28 days' damp curing. Effects of type of cement and aggregate, consistency, quantity of cement, and age before steaming were also investigated.

EFFECT OF MORTAR STRENGTH AND STRENGTH OF UNIT ON THE STRENGTH OF CONCRETE MASONRY WALLS 28-27

R. E. COPELAND and A. G. TIMMS — Apr. 1932, pp. 551-562 (V. 28)

The investigation comprised tests on 108 concrete masonry wallettes laid up with six different mortars which ranged in strength from about 150 to 4800 psi and in cementitious material from 100 percent high-calcium hydrated lime to 100 percent portland cement. The units, which were of three-oval-core design, ranged in strength from 320 to 4180 psi. One other variable, type of aggregate, was included.

Units within the usual commercial strength range (700 to 1000 psi) produced computed wall strengths of 340 to 665 psi or 4½ to 8 times the maximum working stress generally permitted by building codes on walls of hollow units. The relatively high strengths exhibited by the wallettes demonstrated the adequacy of concrete masonry for bearing wall construction.

THE DESIGN AND CONSTRUCTION OF THE MOUNT VERNON MEMORIAL HIGHWAY 28-28

R. E. TOMS and J. W. JOHNSON — Apr. 1932, pp. 563-584 (V. 28)

Traffic and aesthetic considerations were paramount in the design of the Mount Vernon Memorial Highway. Two traffic problems had to be solved: one at the crossing of the Memorial highway and the main Washington-Richmond road, and the other at the Mt. Vernon terminus in providing parking facilities and reversing the flow of traffic. The design of the highway and grade separations is described. A description of the construction includes the following items: riprap, face stone, hydraulic fills, grading, bridges, paving and lighting.

CAST STONE AS A MEANS TO COLOR IN ARCHITECTURE 28-29

FRED R. LEAR — May 1932, pp. 589-596 (V. 28)

A discussion about the future and desirability of using cast stone to add color in modern architecture. Color treatment, including lighting, is also covered.

BENDING AND TORSION IN HORIZONTALLY CURVED BEAMS....28-30

I. OESTERBLOM — May, 1932, pp. 597-606 (V. 28)

In designing horizontally curved beams, one may assume the simple case of complete fixity at the supports and also uniform loading and thereby cover the major part of the problems actually occurring in practice. This article develops the necessary equations and data for purposes of quick and accurate analysis or design of horizontally curved beams.

ADVANTAGES IN THE USE OF HIGH STRENGTH CONCRETES 28-31

THOMAS T. TOWLES — May 1932, pp. 607-612 (V. 28)

Advantages of high strength concrete, $f_c = 2600$ psi, are discussed. From the standpoint of cost there would be marked advantages for designs involving multiple arch spans and single long span crossings. Comparisons are made between standard and high strength concrete in arch and beam construction.

EFFECT OF CELITE ON THE MODULUS OF ELASTICITY OF CONCRETE 28-32

GEORGE A. SMITH — May 1932, pp. 613-626 (V. 28)

This study was limited in its scope; the only variables, aside from the addition of Celite, were the ratio of cement to aggregate and the consistency of the concrete. Other conditions were kept as nearly constant as possible. Under conditions of equal consistency, the tests indicated that the use of Celite for promoting workability had no appreciable effect on the modulus of elasticity or strength of concrete.

CONSTRUCTION OF SIDEWALKS IN THE EXTENSION OF THE U. S. CAPITOL GROUNDS 28-33

LOUIS F. DIETERICH — May 1932, pp. 627-632 (V. 28)

Surface treated, exposed aggregate sidewalks built in the United States Capitol Grounds are described. There were two classes of work, one having gravel, the other granite chips as the coarse aggregate in the topping. Construction procedures are described.

CONCRETE BURIAL VAULT SPECIFICATION 28-34

COMMITTEE 709 — May 1932, pp. 633-636 (V. 28)

Supersedes 27-46

A report of ACI Committee 709 presenting a suggested specification for concrete burial vaults. The committee gives specifications for manufacture of vaults including quality, amount, and placing of reinforcing steel, quality and grading of aggregates, maximum permissible quantity of mixing water, workmanship, finish, etc. The acceptability of vaults under these specifications is determined by compression and absorption tests on cylinders and by loading tests on the finished vault. Adopted as a standard at the 29th annual convention, March, 1932.

THE DESIGN OF CONCRETE ARCHES IN ALLEGHENY COUNTY, PENNSYLVANIA 28-35

G. S. RICHARDSON — June 1932, pp. 637-652 (V. 28)

The design of six concrete arches on the Ohio River Boulevard similar in detail is compared with that of the George Westinghouse Bridge, consisting of five arch spans with the central one the longest constructed in America. Celluloid model studies of the latter bridge showing the effect of various locations of expansion joints and interaction of arch rib and superstructure made with Beggs' deformeter equipment are described. The relation of dead, live, temperature, and shrinkage stresses is discussed and the influence of ratio of depth of rib to span on these stresses is considered.

THE CONSTRUCTION OF CONCRETE ARCHES IN ALLEGHENY COUNTY, PENNSYLVANIA 28-36

V. R. COVELL — June 1932, pp. 653-664 (V. 28)

Forms for arch ribs and spandrel forms were designed to be transferred practically without modification from one arch to another. Arch forms were built especially tight. Three-ply ½-in. veneer boards were used to cover 4 x 4-in. lagging and served as the intrados form. Side forms were 2-in. tongue-and-groove lumber. All seams and cracks were filled with sawdust and glue, after which form oil was applied.

For winter concreting a 2000-ton bin for the sand and gravel was erected in which 1 in. perforated steam pipes were placed at an angle of about 45 deg upward. A 230-ton steel bin for measuring and loading was erected underneath. The total cost of heating for a

daily run of 400 cu yd was about $25. Contractors found it advantageous to use high-early-strength cement in cold weather, which were protected by steam-heated tarpaulins; frequent temperature tests were made by the inspector.

Proceedings V. 29

PAINTING ON CONCRETE SURFACES 29-1

F. O. ANDEREGG — Sept. 1932, pp. 1-7 (V. 29)

The report of Committee 407 provides information on the various inorganic and organic materials painted on concrete surfaces. A paint being no stronger than its foundation, attention must be paid to proper cleaning of the concrete. The effect of moisture in pushing off bodily many surface films, partly by preferential wetting and partly by efflorescent crystal pressure is pointed out. The caustic character of moisture in the concrete endangers many organic films. The ability of a film to "breathe" or transmit water vapor is often an important factor in securing continuing adhesion. Directions are given for the application of hydraulic paints with emphasis on first wetting the concrete and then providing proper curing.

THE MORTAR VOIDS METHOD OF DESIGNING CONCRETE MIXTURES 29-2

MARK MORRIS — Sept. 1932, pp. 9-26 (V. 29)

Author proposes use of mortar voids characteristics of individual sands rather than averages of charactertics of a group of sands to design concrete mixtures of a desired strength. Details of procedure of design are outlined and illustrated and examples of results of application of method for concrete for pavements described. The basic soundness of the mortar void method is confirmed and advantages of refinements in its application stressed.

THE FREYSSINET METHOD OF ARCH CONSTRUCTION APPLIED TO THE ROGUE RIVER BRIDGE IN OREGON 29-3

ALBIN L. GEMENY and C. B. McCULLOUGH — Oct. 1932, pp. 57-79 (V. 29)

The Freyssinet method of arch construction had not been tried in this country until it was introduced in the construction of the Rogue River bridge in Oregon. This method of strain adjustment was studied as well as the behavior of an arch when it is first put under dead load. The compensating strains were produced with batteries of hydraulic jacks placed in one or more radial joints in the arch ribs. The method is simple and effective in eliminating the deleterious effects of rib shortening and permits an adjustment of the arch to its most favorable elastic state under combined dead and live loads. The Freyssinet method permits greater economy in arch construction even in moderate span lengths and makes longer spans and smaller rise ratio practicable.

CENTRAL CONCRETE MIXING PLANT, PUGET SOUND NAVY YARD 29-4

A. D. HUNTER — Oct. 1932, pp. 81-85 (V. 29)

Describes the plant used to supply ready-mixed concrete and crushed stone for the navy yard. The plant layout is described and the economies obtained compared with the previous costs under other conditions. The use of bulk cement is important and this feature contributes largely to the economy and reliability of the plant.

THE STRENGTH OF CONCRETE MASONRY WALLS AFTER STANDARD FIRE EXPOSURE 29-5

C. A. MENZEL — Nov. 1932, pp. 113-142 (V. 29)

Presents data on the load carrying ability of concrete masonry walls made with units of widely varying characteristics, both during and after exposure to standard fire test conditions. Comparative data on similar walls not exposed to fire are included. The investigation comprised tests on more than 200 walls 5½ ft wide, 6 ft high, and 4, 8, and 12 in. thick.

An outstanding feature of the investigation was the substantial load-carrying ability and safety exhibited by the walls before, during and after severe fire exposure.

DESIGN OF CONTINUOUS ARCHES ON ELASTIC PIERS 29-6

A. P. HJORT — Nov. 1932, pp. 143-147 (V. 29)

Presents an arrangement for figuring continuous arches on elastic piers by combining the ordinary slope-deflection method for straight frames and the single arch design through simple statics.

THE ROUND-HEAD BUTTRESS DAM 29-7

FRED A. NOETZLI — Dec. 1932, pp. 161-183 (V. 29)

Describes a buttress type of dam in which the water pressure is supported by buttresses whose upstream portion is enlarged laterally into bulb-shaped heads joined with the buttress heads of the adjacent units, thus providing a continuous upstream face for the structure. The buttress head of each unit has such a shape that the water pressure is transmitted through it into the buttress wall by direct compression. The dam functions substantially in the same manner as an ordinary gravity dam and the design of a buttress unit is in principle similar to that of a vertical slice of a structure of the conventional gravity type. Typical designs are given for buttress units of 35, 50, and 60-ft spans along the water face, suitable for dams from 75 to 350 ft high. A short description is given of the Don Martin round head buttress dam built in Mexico.

LENORA STREET VIADUCT 29-8

CURRAN CAVANAGH — Dec. 1932, pp. 185-188 (V. 29)

A description of the Lenora Street Viaduct in Seattle. Some of the distinguishing features in reinforced concrete design were the use of concrete at a working stress of 1200 psi; continuous girder spans up to 64 ft long freely supported on hinged joints; anchorage to take care of the grade and the tractive effort; the carrying of wind stresses to the end bents; and the use of flexible columns to relieve the bending stresses due to temperature movement.

THE HYDRATION OF TRICALCIUM ALUMINATE 29-9

W. D. FOSTER — Dec. 1932, pp. 189-200 (V. 29)

Studies of the character and rate of hydration of tricalcium aluminate in water and various salt solutions, principally calcium chloride and sulfate; and determination of the rate of hydration of tricalcium aluminate in water alone and with calcium chloride and sulfate admixed. The character of hydration was observed microscopically and the products of hydration identified by their optical properties. Photomicrographs are included. The Hubbel method for determination of the rate of hydration is explained.

SLIDING FORMWORK 29-10

L. BOYD MERCER — Jan. 1933, pp. 201-240 (V. 29)

A practical description of the procedure and pitfalls to be met in the construction and operation of sliding forms. Various types of jacks and the methods for connecting through them to the formwork and operating platform are described in detail. Organization of labor and plant are discussed and while outlining the economies of this method of construction, the report stresses the need for considering sliding forms as a flexible machine capable of presenting many worries for the supervisor. The report concludes with a survey of practical factors which must receive consideration when designing concrete work for construction with sliding forms.

CONCRETING PROBLEMS — CHATS FALLS POWER DEVELOPMENT 29-11

H. L. TROTTER and WILFRID SCHNARR — Feb. 1933, pp. 249-274 (V. 29)

Describes a powerhouse and 3 miles of a dam, the aggregates, proportions, plant, and transportation. The duties of the inspectors and the field laboratory are outlined. Details in placing monolithic concrete, and summer and winter curing are outlined, while experimental data as to the temperature and artificial cooling of concrete are discussed.

REINFORCED CONCRETE COLUMN INVESTIGATION 29-12

COMMITTEE 105 — Feb. 1933, pp. 275-284 (V. 29)

Summarizes results of column tests sponsored by ACI and made at Lehigh University and the University of Illinois. A general equation is given for estimating the ultimate strength of any axially loaded concrete column. The effect of plastic flow and shrinkage are discussed. Design formulas for spiral and tied columns are proposed and other general design provisions formulated.

SLIDING FORMWORK 29-13

W. R. SPROUL — Feb. 1933, pp. 285-299 (V. 29)

Data and descriptions are presented of methods in applications of sliding forms, especially in reference to rectangular structures of high, clear story height and free standing single and double walls, as employed in cold storage and ice storage houses. The basic principles of operation and erection are similar to those employed in erection of grain elevators. Drawings are included.

MASS CONCRETE RESEARCH FOR HOOVER DAM 29-14

BYRAM W. STEELE — Mar.-Apr. 1933, pp. 305-317 (V. 29)

The advent of a mass concrete dam 726 ft high necessitated a thorough investigation of such subjects as volume change, foundation and contraction joint grouting, portland cement, mass concrete strength and mix proportions, elastic and thermal properties of mass concrete, permeability, precooling concrete ingredients versus concrete refrigeration, action under axial, biaxial and triaxial loads, bond and sliding friction, shear, uplift, and durability. Of these problems, the ones of most vital importance from the construction standpoint were attacked first and solutions obtained that justified the procedure actually followed.

AN 8-HOUR ACCELERATED STRENGTH TEST FOR FIELD CONCRETE CONTROL 29-15

O. G. PATCH — Mar.-Apr. 1933, pp. 318-324 (V. 29)

Describes a practical method of determining the potential 28-day strength of concrete within 8 hr after mixing. The method is valuable in predicting the effect of changes in mixes, as well as in calling attention to gradual changes in strength due often to otherwise unrecognized conditions and is also helpful in mix design.

RELATION BETWEEN QUALITY AND ECONOMY OF CONCRETE . . . 29-16

INGE LYSE — Mar.-Apr. 1933, pp. 325-343 (V. 29)

Presentation is made of the inter-relation between the strength, permeability, durability, fire resistance, and volume changes of concrete. By means of the constant water content theory a study is made of the relation between the strength of the concrete and the economy of plain and reinforced concrete members. The influence of quality of cement, gradation of aggregate, and prices of cement and aggregate on the economy of the concrete is included in the study.

VOLUMETRIC CHANGES IN NEAT CEMENTS AND MORTARS 29-17

R. E. MILLS — Mar.-Apr. 1933, pp. 344-350 (V. 29)

A series of long-time studies of the volumetric changes of different brands of portland cements and masonry cements has been conducted at the Materials Testing Laboratory, Purdue University. Comparative observations of volume change and weight change for nine different brands of portland cements are shown graphically extending over 8 years. Similar data are also presented covering observations on eight different masonry cements for 2 years.

TECHNOLOGICAL DEVELOPMENTS IN FIREPROOF CONCRETE HOMES . . 29-18

W. D. M. ALLAN and R. E. COPELAND — Mar.-Apr. 1933, pp. 351-364 (V. 29)

In this article the authors trace briefly the technological progress made in house construction during the years just prior to 1933. They describe briefly some of the systems which had been used prior to 1933 and discuss some of the more recent developments, including lightweight aggregates, concrete ashlar, color treatments, sound absorption, and precast joists.

COMPACTION OF CONCRETE THROUGH THE USE OF VIBRATORY TAMPERS 29-19

RAYMOND E. DAVIS and HARMER E. DAVIS — June 1933, pp. 365-372 (V. 29)

Summarizes findings of tests made to study relative advantages of vibratory tamping as compared with hand tamping with regard to: ease of placement, form pressures, homogeniety of concrete, bond of new concrete to old, strength, density, and durability of concrete. Both internal and external vibratory tampers were employed.

VIBRATED CONCRETE 29-20

T. C. POWERS — June 1933, pp. 373-381 (V. 29)

Following field tests of internal vibrators, laboratory investigations of the relation of strength to cement-voids ratio, of the proper mix characteristics for vibration, and freezing and thawing tests were made. It was found that for a mix to be placed successfully by vibration it must be plastic or become plastic under vibration. The relationship between the cement-voids (voids = water plus air) ratio is substantially the same for vibrated as for hand-placed concrete.

THE USE OF VIBRATION IN THE MANUFACTURE OF CONCRETE PRODUCTS 29-21

MILES N. CLAIR — June 1933, pp. 383-390 (V. 29)

Discusses the variables involved in the application of vibration to the manufacture of concrete products including characteristics of the vibration, method of application, characteristics of the mass to be vibrated, and purpose of the vibration.

Concludes that vibration practice in the concrete products field must be determined by previous experience plus thorough investigation for the case considered. What is the best will be determined by cost and by the characteristics of the product measured by tests for absorption, compressive strength, modulus of rupture, and voids.

VIBRATORY FINISHING MACHINE FOR CONCRETE PAVEMENTS 29-22

F. V. REAGEL — June 1933, pp. 391-396 (V. 29)

A vibrating-screed type finishing machine and a standard type Ord finisher were used in a series of tests on a concrete paving project. The results of the tests definitely indicate that leaner mixes can be satisfactorily finished by the vibratory

method without sacrificing quality of the concrete. This indicates that a potential saving in the cost of materials can be effected.

THE TEMPLE OF LIGHT 29-23

ALLEN B. McDANIEL — June 1933, pp. 397-401 (V. 29)

In June, 1920, at an annual meeting of the followers of the universal Faith of Baha'u'llah (Arabic for Glory of God), the delegates from the United States and Canada selected a design for their House of Worship to be erected in the village of Wilmette, Ill., on the western shore of Lake Michigan. This design was submitted by Louis Bourgeois in the form of a beautiful plaster model.

Twelve years were spent by an advisory committee of engineers and architects in an extended research to determine available materials and methods of construction to practically execute such an unusual and unique design. On the recommendations of this committee, the Temple trustees finally authorized construction in two steps; first, the building of a skeleton structure of the general form of the design, and second, the "clothing" of this structure with the ornamentation.

Work began in 1921 with the foundations; in 1930 and 1931, the superstructure was erected. On June 6, 1932, the Earley Studio, Washington, D.C., was awarded the contract for the preparation and application of the exterior ornamentation for the dome of the Temple.

THE PROJECT OF ORNAMENTING THE BAHA'I TEMPLE DOME 29-24

JOHN J. EARLEY — June 1933, pp. 403-411 (V. 29)

A discussion of the problems faced in ornamenting the Baha'i Temple dome. A full-size model of the dome was constructed in the studio prior to casting the architectural concrete slabs.

CEMENT INVESTIGATIONS FOR THE HOOVER DAM 29-25

RAYMOND E. DAVIS, R. W. CARLSON, G. E. TROXELL and JOE W. KELLY — June 1933, pp 413-431 (V. 29)

Describes investigations at the University of California to determine the best type of cement for construction of Hoover Dam. Ninety-three commercial and laboratory cements of wide range of composition were tested to determine principally the effect of chemical composition and fineness of cement on heat of hydration, strength, volume change, and durability of mortar and concrete. The effect of each major compound in cement was computed in the form of contribution factors. Strength-heat ratio was shown to be a significant property. Effect of variations in curing temperature on heat of hydration and strength were determined. New methods of measuring fineness and heat generation of cement were developed.

FIFTH REPORT ON COLUMN TESTS AT LEHIGH UNIVERSITY 29-26

INGE LYSE — June 1933, pp. 433-442 (V. 29)

Results of Series 4 of the ACI column investigation — tests on the amount of load a reinforced concrete column will sustain indefinitely. A total of 28 columns were included in this series. The number of tests was inadequate for drawing final conclusions but the results indicated that (a) the longitudinal reinforcement will carry its full yield-point stress at strains far beyond the yield-point strain, (b) the strength of the column was not decreased by being strained far beyond the yield point of its steel before the loading to failure and (c) a reinforced concrete column (tied or spiral column) will probably carry nearly 80 percent of its ultimate load for an indefinite time.

Proceedings V. 30

THE EFFICIENCY OF SURFACE TREATMENTS ON THE PERMEABILITY OF CONCRETE 30-1

GEORGE W. WASHA — Sept.-Oct. 1933, pp. 1-8 (V. 30)

Presents the results of tests on the efficiency of surface treatments in preventing flow of water through concrete. Results obtained indicate the relative effectiveness of 24 different surface treatments shortly after their application, and also values for nine of these treatments after 2 years of outdoor exposure.

A COMPARISON OF SELECTED PORTLAND CEMENTS IN MASS CONCRETE TESTS 30-2

ROBERT F. BLANKS — Sept.-Oct. 1933, pp. 9-20 (V. 30)

A discussion of results of tests made to determine the influence of the four principal compounds of portland cement on the heat generation and strength development of mass concrete with supplemental information on apparatus, methods, and range of the tests.

DEVELOPMENT OF LARGE CALORIMETER ROOMS AND AUTOMATIC TEMPERATURE CONTROLS FOR ADIABATIC CURING OF MASS CONCRETE 30-3

HARMON S. MEISSNER — Sept.-Oct. 1933, pp. 21-26 (V. 30)

Describes the construction of calorimeter rooms for the curing of large size concrete test specimens under conditions occurring within mass concrete. By special apparatus, the temperature of the room is controlled to agree with the rising temperature of the hermetically sealed, newly cast, concrete contained within it, producing a temperature cycle identical to that in the interior of large concrete masses. Knowing the specific heat of the concrete, the heat of hydration of the cement is computed from such adiabatic temperature rise.

MASS CONCRETE AS AFFECTED BY SIZE OF AGGREGATE AND RELATED FACTORS 30-4

ARTHUR RUETTGERS — Sept.-Oct. 1933, pp. 27-34 (V. 30)

Outlines the details of a program of tests undertaken by the Bureau of Reclamation, on a scale never before attempted, to investigate the effects of size of aggregate, mix proportions and size of test specimen on compressive strength, elastic properties, and permeability of mass concrete. Some of the early test results and indications are presented. Use was made of test cylinders as large 3 ft x 6 ft, of aggregate up to 9 in. in size, and of extraordinary testing facilities including a 4,000,000 lb capacity testing machine.

THERMAL PROPERTIES OF MASS CONCRETE 30-5

C. S. RIPPON and L. J. SNYDER — Sept.-Oct. 1933, pp. 35-40 (V. 30)

This paper is one of a group of eight covering extensive investigation into properties of mass concrete in connection with the construction of Boulder Dam. It deals with thermal properties of mass concrete and describes apparatus and test methods used in measuring the thermal conductivity, specific heat, density, and diffusivity of concrete specimens. Results of tests on concrete samples made with various aggregates are presented in graphical form.

DEVELOPMENT OF APPARATUS AND TECHNIQUE FOR MEASURING ELASTICITY OF MASS CONCRETE . . 30-6

EMILE N. VIDAL — Sept.-Oct. 1933, pp. 41-47 (V. 30)

The determination of elastic properties of mass concrete in test specimens up to 36 x 72 in. is described in detail with appropriate discussion of the equipment required and the test technique. Calibration of the instruments is described and some general test results are included.

HIGH FREQUENCY VIBRATORY MACHINES FOR CONCRETE PLACEMENT 30-7

M. I. McCARTY — Sept.-Oct. 1933, pp. 49-53 (V. 30)

Three mechanical factors in the vibration of concrete are of importance: frequency, amplitude or force of the action, and use of the correct machines for the job in hand. Various vibrators and their use are described.

PLACEMENT OF CONCRETE BY MECHANICAL VIBRATION 30-8

A. W. MUNSELL — Sept.-Oct. 1933, pp. 54-56 (V. 30)

Recounts experiences encountered in the use of vibration for placing concrete.

VIBRATION ON MICHIGAN BRIDGE WORK 30-9

A. C. BENKELMAN — Sept.-Oct. 1933, pp. 57-58 (V. 30)

A summary of Michigan State Highway Department experience with the use of vibration in bridge work.

VIBRATING EQUIPMENT IN A CAST STONE PLANT 30-10

GEORGE B. PICKOP — Sept.-Oct. 1933, pp. 59-60 (V. 30)

Advantages and uses of vibrating equipment in the manufacture of cast stone are cited.

FABRICATING 36-IN. REINFORCED CONCRETE-STEEL CYLINDER WATER MAINS 30-11

J. F. BRETT — Sept.-Oct. 1933, pp. 61-62 (V. 30)

Details of fabrication of approximately 60,000 lin ft of 36-in. water main designed for an operating pressure of 120 psi for the metropolitan system of Montreal. Straight pipes consist of a steel cylinder shell on which a spiral reinforcing cage is wound, after placing a 1¼ in. inside lining by centrifugation. An outside lining 2¼ in. thick is then placed with vibrators.

VIBRATION IN MAKING ROOF DECK SLABS 30-12

A. B. SHENK — Sept.-Oct. 1933, pp. 63-64 (V. 30)

Experience has shown that the use of vibration facilitates manufacture of precast roof slabs. Examples are given.

STRESSES AT A CRACK, SIZE OF THE CRACK AND THE BENDING OF REINFORCED CONCRETE 30-13

H. M. WESTERGAARD — Nov.-Dec. 1933, pp. 93-102 (V. 30)

A study by the theory of elasticity leads to the conclusion that directly above a crack in a horizontal reinforced concrete beam the horizontal strains do not have a straight-line distribution as assumed in the standard theory. Instead, the diagram of horizontal compressive strains or stresses may be drawn approximately as a parabola with apex at the end of the crack and with vertical axis. At the ultimate load the stress diagram may be approximately a quadrant of a circle. This suggests a need for revision of the standard theory.

A NEW TYPE OF DAM 30-14

A. C. JANNI — Nov.-Dec. 1933, pp. 103-109 (V. 30)

The new type of arch dam proposed has been evolved to avoid the many design uncertainties existing in the usual arch dam. The main frame consists of a series of arches, supported at various points by cantilevers; each arch butts against solid rock at each end, independently from each other, also each cantilever can be made to reach solid rock independently of each other. Two systems of beams, one horizontal the other vertical, run in each panel formed by two consecutive arches and two consecutive cantilevers. Slabs, independent from each other, are cast against those beams.

SIMPLIFIED CONCRETE MIX DESIGN 30-15

H. N. WALSH — Nov.-Dec. 1933, pp. 110-120 (V. 30)

Contains grading curves of aggregates (both ¾ in. and 1½ in. maximum sizes). Each grading makes dense and workable concrete with a specified proportion of cement. Corresponding water-cement ratios and cement contents of set concrete are given; a straight line relation between cement-water ratio by weight and strength is included. A simple method of proportioning from the above data is illustrated by an example.

DURABILITY STUDIES OF CONCRETE AND AGGREGATES 30-16

INGE LYSE and J. M. HOLME — Nov.-Dec. 1933, pp. 121-128 (V. 30)

Results of tests of ten different aggregates, six natural sand and gravels, three types of crushed limestone and one crushed iron ore and steel punchings were: (1) a fair agreement was found between the results of the sodium sulfate tests and the freezing and thawing tests of the fine aggregate; (2) the relation between durability and cement-water ratio was similar to the relation between strength and cement-water ratio; (3) a fair correlation was found between the durability tests of the aggregates and of the concrete; and (4) the natural sand and gravel aggregates produced a more durable concrete than did the limestone aggregates included in this investigation.

EARTHQUAKE DAMAGE TO MASONRY STRUCTURES AND THEIR REPAIR 30-17

L. T. EVANS and M. ROSSEN — Nov.-Dec. 1933, pp. 129-136 (V. 30)

Authors cite some of the lessons learned and show some of the repair methods used on brick and concrete structures damaged by earthquake at Long Beach, Calif. A majority of failures in brick structures were of two types: diagonal fractures that usually followed mortar joints, and horizontal shear cracks. Most of the damage in reinforced concrete structures was due to poor design or poor construction. Repair methods included the use of shotcrete "welds."

The authors recommend design procedures to eliminate much of the damage resulting from earthquakes.

PLASTIC FLOW IN PLAIN AND REINFORCED CONCRETE ARCHES . . . 30-18

E. PROBST — Nov.-Dec. 1933, pp. 137-141 (V. 30)

Discusses laboratory investigations in regard to the plastic flow of concrete in plain and reinforced arches. The effect of the equalization of stress distribution at early ages, the effect of plastic shrinkage and other factors which have beneficial effect on concrete structures do not require development of a new theory but an expansion of present methods to include the properties of materials.

SELECTING CONCRETE PLANT — MEADOWBROOK HOSPITAL 30-19

JOHN G. AHLERS — Nov.-Dec. 1933, pp. 142-152 (V. 30)

An analysis of four types of concrete plant for a scattered group of hospital buildings presents an approach to the problem of selection of the best and most economical type. Final reasoning leading to a central plant and distribution of concrete by special truck, hopper type, concludes the paper.

TEMPERATURE EFFECTS ON COMPRESSIVE STRENGTH OF CONCRETE 30-20

A. G. TIMMS and N. H. WITHEY — Jan.-Feb. 1934, pp. 159-180 (V. 30)

Reports strength tests of concrete made with normal and high-early-strength cements stored at different temperatures. Water content, preliminary curing, and age at test varied. Gain in strength following a given initial treatment was dependent on the temperature of exposure. The importance of initial curing at a favorable temperature was clearly indicated. Subsequent warming of concrete exposed to temperatures of 50 and 33 F did not help later strengths much when no moisture was supplied. The tests also indicated the danger of placing concrete having a temperature less than 70 F when temperatures below freezing are likely to be encountered.

THE EFFECT OF PLASTIC FLOW IN RIGID FRAMES OF REINFORCED CONCRETE 30-21

F. E. RICHART, R. L. BROWN and T. G. TAYLOR — Jan.-Feb. 1934, pp. 181-195 (V. 30)

Tests of ten rigid frames, 5 ft 9½ in. high, 7 ft 7 in. wide, were made to study the effect of sustained loading for 2 years on stress distribution. Measurements were taken of strains in concrete, tension and compression steel, deflections, rotations, and changes in horizontal reactions of the two-legged frames. An evaluation of the effect of time yield on flexural members is made.

RIGID FRAME CONCRETE BRIDGES . . 30-22

J. W. BERETTA — Jan.-Feb. 1934, pp. 196-208 (V. 30)

Presents a discussion of statically indeterminate design as applied to bridges. Continuous indeterminate types of bridges may take the form of horizontal continuity over multiple spans, restraint in the form of rigid frame continuity, or a combination of both.

PROPER METHODS OF DESIGN AND CONSTRUCTION OF CONCRETE STRUCTURES TO PREVENT DAMAGE FROM VOLUMETRIC CHANGES OF THE CONCRETE 30-23

G. E. TROXELL — Jan.-Feb. 1934, pp. 209-230 (V. 30)

Summarizes known information concerning volume changes of concrete, outlines research required to determine the unknown effect of certain factors on volume changes, and indicates how damage of structures due to volume changes may be at least partially prevented by proper choice of materials used and proportioning of the mix, by correct design of the structure, and by proper construction methods.

ULTIMATE STRENGTH AND MODULUS OF ELASTICITY OF HIGH STRENGTH PORTLAND CEMENT CONCRETE . . . 30-24

WILLIAM H. THOMAN and WARREN RAEDER — Jan.-Feb. 1934, pp. 231-238 (V. 30)

A study of Young's modulus for portland cement concretes of strengths from 2000 to 12,000 psi. The modulus was found to vary with the strength regardless of age, also, with the strength of the coarse aggregate.

STRUCTURAL DESIGN OF BAHA'I TEMPLE 30-25

BENJAMIN B. SHAPIRO — Jan.-Feb. 1934, pp. 239-246 (V. 30)

Design of the Baha'i Temple was divided into two divisions — foundation and superstructure. The superstructure was to be that portion of the building above the first floor, the design to be preliminary in form, enough to determine structural reactions and loads. The substructure design was to be final. The structural design as presented in the article is similar to a log of the construction of the building.

PRESIDENT'S ADDRESS 30-26

S. C. HOLLISTER — Mar.-Apr. 1934, pp. 247-250 (V. 30)

Retiring President Hollister views the state of the Institute not in the traditional light of receipts and disbursements, assets and liabilities; but rather in the broader view of the Institute's work in relation to the field which it serves.

ARCHITECTURAL CONCRETE OF THE EXPOSED AGGREGATE TYPE . . . 30-27

JOHN J. EARLEY — Mar.-Apr. 1934, pp. 251-278 (V. 30)

This paper is a continuation of "The Project of Ornamenting the Baha'i Temple Dome," ACI Journal, June 1933. Describes some of the techniques by which architectural concrete of the exposed aggregate type has been developed and some of the methods by which the ornamentation of the Temple has been done.

MANUFACTURING CONCRETE DURING COLD WEATHER 30-28

R. B. YOUNG and WILFRID SCHNARR — Mar.-Apr. 1934, pp. 279-291 (V. 30)

Discusses the problems of winter concreting of how much heat needs to be supplied to concrete under different conditions and how that heat can be most advantageously introduced into the mix. Topics include the form temperatures, temperature of concrete when delivered to the forms, heat losses in transportation, temperature of the ingredient materials, and methods of heating.

COLD WEATHER PROTECTION OF CONCRETE 30-29

R. B. YOUNG and WILFRID SCHNARR — Mar.-Apr. 1934, pp. 292-304 (V. 30)

It is not difficult nor expensive to provide satisfactory curing conditions for concrete in cold weather. Success depends on simple precautions and careful planning. The authors outline correct techniques and list precautions that must be considered.

VIBRATING CONCRETE AT PINE CANYON DAM 30-30

SAMUEL B. MORRIS and ROSS WHITE — Mar.-Apr. 1934, pp. 305-310 (V. 30)

The use of both internal and platform type electric vibrators at 4400 to 4700 rpm on mass concrete with 6 in. cobbles and less than 1 in. slump gave the same strength as concrete with 21 per cent more cement and at lower cost in this 325 ft high concrete gravity dam.

Other benefits were: (1) a more dense concrete, (2) better bond between lifts, (3) better surface finish and appearance, (4) lower temperature rise, and (5) absence of any damp spots on downstream face of dam.

SOME TESTS OF LOAD CAPACITY OF FLOORS MADE WITH PRECAST CONCRETE JOISTS 30-31

R. E. COPELAND and P. M. WOODWORTH — Mar.-Apr. 1934, pp. 311-324 (V. 30)

This is a progress report of an investigation of the structural performance of a floor construction consisting of precast reinforced concrete joists with cast-in-place or precast 2 or 2½ in. reinforced concrete slab.

Variables studied include: welded joist reinforcement, effectiveness of diagonal as compared with vertical stirrups, type of aggregate, type of bond of slab to joist, and performance of precast as compared with cast-in-place slab.

A METHOD OF EVALUATING ADMIXTURES 30-32

F. R. McMILLAN and T. C. POWERS — Mar.-Apr. 1934, pp. 325-344 (V. 30)

A powdered admixture should be rated by its effectiveness in producing the specific properties desired in concrete, in comparison with other means of producing the same effect. In this paper, several admixtures are rated in terms of the quantity of portland cement having the same effect as a unit quantity of admixture with respect to: (1) an equivalent change in compressive strength and (2) an equivalent change in paste volume.

THE TORONTO BUILDING BY-LAW . . 30-33

J. MORROW OXLEY — Mar.-Apr. 1934, pp. 345-359 (V. 30)

This paper, presented when a new building by-law or code was still in preparation, deals principally with the chapter on reinforced concrete, then complete.

Established conventions are followed except in regard to two-way slabs, for which new formulas for moment coefficients were adopted, and the definition of "equal" in span length of continuous beams of constant depth for application of conventional bending moment formulas. As this code was compiled before design by moment distribution gained acceptance and applicability it has no particular value except historically.

EXPERIMENTAL STUDY OF STRESSES AT A CRACK IN A COMPRESSION MEMBER 30-34

S. C. HOLLISTER — Mar.-Apr. 1934, pp. 361-365 (V. 30)

Reports the results of a series of photoelastic tests made to study stresses at a crack occurring in a compression region. The distribution of stress difference appears to vary with the position of the resultant compression, with respect to the net section, as well as with the form of the notch or crack.

PROPOSED STANDARD SPECIFICATION FOR THE DESIGN AND CONSTRUCTION OF REINFORCED CONCRETE CHIMNEYS 30-35

E. A. DOCKSTADER — Mar.-Apr. 1934, pp. 367-368 (V. 30)

Superseded by 51-1

A brief summary of a specification for reinforced concrete chimneys. The specification sets forth recommended loadings, including provision for both wind and earthquake, for the design of reinforced concrete chimneys and methods for determining the stresses resulting from these loadings. The method of analysis includes determination of the stresses where flue openings occur as well as at sections where the cross section is an annular ring. Charts containing curves to aid in the rapid solution of the specified formulas are included.

Recommended formulas are given for determining the temperature gradient through the concrete resulting from the temperature of the gases inside the chimney and the surrounding atmosphere, together with methods of determining the stresses in the concrete and reinforcement, both vertically and circumferentially due to the temperature gradient through the concrete. Methods of combining these stresses with those due to dead load, wind, and earthquake are included, together with recommended allowable stresses for the various stress combinations.

The specification includes recommended practice concerning the mixing, placing, and curing of concrete in chimneys and for lightning protection, access ladders, and other chimney accessories.

An appendix covers the derivation of all the formulas used in the specification and sets forth the assumptions on which the formulas are based.

Note — This paper is a summary only of the specification.

PROPERTIES OF MORTARS AND CONCRETES CONTAINING HIGH-SILICA CEMENTS 30-36

RAYMOND E. DAVIS, R. W. CARLSON, JOE W. KELLY, and G. E. TROXELL — Mar.-Apr. 1934, pp. 369-389 (V. 30)

Authors define high-silica cements as including low-lime portland cements, portland-pozzolan cements, pozzolan-lime cements, and sand cements. They discuss principally portland-pozzolan cements and describe types of pozzolan, give history of their use, and interpret past experience and research. Paper describes a cooperative program of research in progress at the University of California on 60 portland-pozzolan cements differing from one another in chemical composition of the portland cement clinker and in chemical composition, physical character, and proportions of pozzolanic material, to determine their effects on strength, resistance to weathering and to sulfate waters, heat of hydration, volume changes, etc., under a wide variety of curing conditions.

OBSERVATIONS ON EUROPEAN PRACTICE IN CONCRETE DESIGN AND CONSTRUCTION 30-37

B. MOREELL — May-June 1934, pp. 391-406 (V. 30)

States that European practice tends towards greater refinement in theoretical analysis and in attention to minor details than American practice because material costs are higher and labor costs lower. More reliance is placed on theory and less on test results. Construction procedures are not as accurately controlled as in the best American practice. Paper includes French standards for materials including reinforcing steel, cement, aggregate, concrete, and for design including calculation of strength, shrinkage and temperature changes, design loads, allowable stresses, compression steel, tension steel, diagonal tension reinforcement, and lateral reinforcement of compression members.

CONCRETE AS A MEDIUM OF ARCHITECTURAL EXPRESSION IN BUILDING 30-38

ALFRED CHAPMAN — May-June 1934, pp. 407-421 (V. 30)

A discussion about the use of concrete as a medium of architectural expression. Illustrations of examples are given.

BONDING OF NEW CONCRETE TO OLD AT HORIZONTAL CONSTRUCTION JOINTS 30-39

RAYMOND E. DAVIS and HARMER E. DAVIS — May-June 1934, pp. 422-436 (V. 30)

Presents results of tests to determine the relative efficiency of various methods of bonding new concrete to old under conditions similar to those that exist along horizontal construction joints in dams. Authors discuss the effect of several methods of placement and several methods of joint treatment on: permeability along plane of joint, bond strength as indicated by the flexure test, and quality of concrete as indicated by unit weight and compressive strength. Methods of compaction

were hand tamping, internal vibratory tamping, and combined internal and surface vibratory tamping. Methods of surface cleanup were wire-brushing, scouring with air-water jet before final set, cleaning with high-pressure air after final set. In some cases, lifts were deposited directly on the surface of the previous lift; in other cases, a layer of mortar was flushed on the old surface first. The following variables were included: richness of mix, type of cement, consistency of concrete, period of exposure of lower lift to drying in warm air, time interval between lifts, and age of concrete at test.

DOES CEMENT PROTECT A POOR QUALITY AGGREGATE? — YES AND NO 30-40

E. VIENS — May-June 1934, pp. 437-447 (V. 30)

Four different aggregates are dealt with in this paper. Pros and cons are given for the various cases of poor quality aggregates used in exposed structures in answer to the question of protection by cement.

TESTS OF REINFORCED CONCRETE T-BEAMS 30-41

T. D. MYLREA — May-June 1934, pp. 448-464 (V. 30)

A series of tests on T-beams of 10-ft span with reinforcing bars of various size, arrangement and manner of anchorage indicates that while bond may be depended on at the usual stresses it cannot be depended on at those high stresses which might prove economical. With proper anchorage it is possible to develop the elastic limit of any commercial steel, and with proper bending and anchorage the question of bond is eliminated and shear stresses are governed only by the strength of the concrete in diagonal compression.

TENDENCIES IN CANADIAN RAILWAY BRIDGE DESIGN — RECENT WORK ON THE CANADIAN NATIONAL RAILWAYS 30-42

H. S. VAN SCOYOC — May-June 1934, pp. 465-478 (V. 30)

Developments in bridge design made by the Canadian National Railways, Canada, from 1921 to 1934 are described. These include (1) simple beam cast-in-place, (2) simple beam precast, (3) span continuous over center support, cast-in-place, with concrete ties, (4) precast beam continuous over center support, (5) rigid frame, continuous over center support, cast-in-place, (6) single span, rigid frame, cast-in-place without ties or ballast, and (7) through plate girder, with steel floor, beams, carrying reinforced concrete T-section slab without ties or ballast.

Special emphasis is placed on reduction in height required from top of roadway to top of rail by omission of ties and ballast.

RIGID FRAME HIGHWAY BRIDGES IN ONTARIO 30-43

ARTHUR SEDGWICK — May-June 1934, pp. 479-484 (V. 30)

A brief account of the advantage of rigid frame construction over earlier types, such as girder and slab, steel trusses, and conventional concrete arches. This new type has been extensively used on Ontario highways since 1931.

In the experience of the author, rigid frame design has marked advantages in regard to economy in initial and maintenance costs, in appearance, and in amount of head room afforded.

CEMENT INVESTIGATIONS FOR BOULDER DAM WITH THE RESULTS UP TO THE AGE OF ONE YEAR....30-44

RAYMOND E. DAVIS, R. W. CARLSON, G. E. TROXELL, and JOE W. KELLY — May-June 1934, pp. 485-497 (V. 30)

This paper, supplementary to paper No. 29-25, presents the later age results of tests at the University of California to determine the best type of cement for construction of Boulder Dam. It discusses effect of chemical composition and fineness of cement on water requirement for workability, heat of hydration, compressive strength, strength-heat ratio, volume change, and durability (resistance to weathering and to sulfate waters). For some of the properties, contribution factors for each major compound in cement are given.

DESIGN OF TWO-WAY SLABS ON BEAMS 30-45

E. H. UHLER — May-June 1934, pp. 498-503 (V. 30)

The theoretical formula by H. M. Westergaard and the proposed empirical formulas of the Chicago, New York, Boston, and German building codes are at variance in the design of two-way slabs on beams. Author discusses these variations and recommends Westergaard's curves.

TWO-WAY SLABS IN THE PROPOSED BUILDING CODE FOR BOSTON AND NEW ENGLAND 30-46

JOHN R. NICHOLS — May-June 1934, pp. 504-509 (V. 30)

The authors of a new building code, seeking a method of design for two-way slabs, strove for the qualities of simplicity, adherence to familiar forms, adequate safety, reasonable economy, and avoidance of obvious irrationality; and adopted an empirical formula which takes separate account of continuity in the direction of the span, lateral continuity and shape of the panel.

Proceedings V. 31

LIGHTWEIGHT SLAG CONCRETE ... 31-1

INGE LYSE — Sept.-Oct. 1934, pp. 1-7 (V. 31)

Tests of concrete containing porous slag as coarse aggregate and natural sand as fine are described. The weight of the concrete was reduced considerably by the porous slag. Compressive, flexural and diagonal tension strengths as well as bond strengths and modulus of elasticity of the concrete were nearly the same for slag as for gravel aggregates.

CONSISTENCY INDICATOR FOR A READY-MIXED CONCRETE PLANT... 31-2

E. B. RAYBURN, JR. — Nov.-Dec. 1934, pp. 105-112 (V. 31)

Data are presented on the performance of a consistency indicator installed in the mixer of a ready-mixed concrete plant.

The device was developed to fill the need for uniform consistency and strength results. Concrete is proportioned on a strength basis, and is controlled by producing the desired consistency, the amount of water required having been predetermined in the laboratory. As long as consistency is accurate, strength results will be accurate, and this can only be controlled mechanically.

The indicator gave other interesting results — reduced the factor of safety and produced more uniform concrete.

FLOW OF HEAT IN DAMS 31-3

ROBERT E. GLOVER — Nov.-Dec. 1934, pp. 113-124 (V. 31)

Formulas are presented for computing temperature changes in concrete dams. Charts are included to facilitate computation of the time required to lose the setting heat and for estimating the effect of seasonal temperature changes.

STRENGTH AND VOLUME CHANGE OF STEAM-CURED PORTLAND CEMENT MORTAR AND CONCRETE 31-4

CARL A. MENZEL — Nov.-Dec. 1934, pp. 125-148 (V. 31)

Studies were made to bring out the possibilities and limitations of high-pressure steam curing for

practical application to the manufacture of concrete products. The investigation was concerned primarily with the strength and volume changes of cement pastes and mortars, and mixtures of cement and finely divided silica in both neat and mortar specimens, cured in saturated steam at high temperatures and pressures for different periods. Companion moist-cured specimens were made and subjected to the same tests as those which were steam cured.

CONCRETE IN FACTORY CONSTRUCTION 31-5

L. F. FAIRCHILD — Nov.-Dec. 1934, pp. 149-164 (V. 31)

Practices followed in the construction and maintenance of concrete structures in the several factories of the Eastman Kodak Co. are described. Construction features described include: reinforcing steel, steel sash, painting, expansion joint repairs, beam repairs, floor finish, waterproofing, foundations, central mixing plant, concrete poles, and tanks.

FURTHER STUDIES OF TEMPERATURE EFFECTS ON COMPRESSIVE STRENGTH OF CONCRETE 31-6

A. G. TIMMS and N. H. WITHEY — Nov.-Dec. 1934, pp. 165-180 (V. 31)

Supplements an earlier paper by the same authors and presents effect of moist curing subsequent to exposure to low temperatures on concrete strength. Temperature of making and curing and duration of subsequent moist curing were varied. Where development of normal strength had been retarded by exposure to low temperatures, practically the full potential strength of the concrete was obtained by storage in warm water for a sufficient period. Concrete stored in water at a given low temperature developed a much higher proportion of its potential strength than concrete stored for the same period and temperature in dry air.

PROGRESS REPORT ON BUILDING REGULATIONS FOR REINFORCED CONCRETE 31-7

COMMITTEE 501 — Nov.-Dec. 1934, pp. 181-183 (V. 31)

Committee 501 progress report.

TRENDS IN THE PRODUCTION AND USE OF VARIOUS TYPES OF HYDRAULIC CEMENTS 31-8

P. H. BATES — Jan.-Feb. 1935, pp. 225-240 (V. 31)

The situation regarding the types of hydraulic cements on the market and the various service demands is reviewed. It is pointed out that the thought that one standard cement can be used to meet all commercial demands is rapidly being discarded. The nature of the cements available and some of their properties are briefly presented. The reasons why there is a demand for a variety of cements are discussed. Producers and consumers are cautioned that all types of cement may not be used successfully to make concrete suitable for all services.

HIGH EARLY STRENGTH CEMENTS IN CONCRETE PRODUCTS MANUFACTURE 31-9

BENJAMIN WILK — Jan.-Feb. 1935, pp. 241-246 (V. 31)

A series of tests using one high-early-strength and one ordinary portland cement are described. The author concludes that where it is necessary to put products on jobs quickly, it is apparent that high-early-strength cements will prove valuable.

EFFECT OF BRAND AND TYPE OF CEMENT ON STRENGTH AND DURABILITY OF CONCRETE 31-10

INGE LYSE — Jan.-Feb. 1935, pp. 247-271 (V. 31)

A presentation of results of an investigation of the strength and durability of concrete containing 18 different cements, 13 standard portland cements and 5 high-early-strength cements. The strength as well as the durability of the concrete containing different cements varied considerably. The durability was generally found to be independent of the strength. Both strength and durability of the concrete seemed to be independent of the chemical composition of the cements tested, indicating that the method of manufacturing the cement may have been the most important cause of the variation in the quality.

WATER RETAINED IN HARDENED CEMENT PASTES 31-11

RAYMOND WILSON and FRANK A. MARTIN — Jan.-Feb. 1935, pp. 272-279 (V. 31)

Many of the physical properties of concrete are dependent on the quantity of water in the concrete; strength, permeability, durability, and volume changes are some of these properties. Believing that a knowledge of the influence of temperature and relative humidity on the equilibrium water content of hydrated cement pastes would be of assistance in interpreting phenomena associated with varying water content, the authors present data showing quantity of water remaining in cement pastes after drying, as influenced by the water-cement ratio, the duration of curing, and the temperature at which drying occurs.

MASS CONCRETE TESTS IN LARGE CYLINDERS 31-12

R. F. BLANKS and C. C. McNAMARA — Jan.-Feb. 1935, pp. 280-303 (V. 31)

A full report on the investigations of the effect of large coarse aggregate on the strength and elastic properties of mass concrete and of the use of large cylinders in compression tests. This study shows that when testing a given concrete in cylinders of different sizes, the strength decreases as the size of cylinder is increased and that for a given consistency the strength per unit of cement is increased as the maximum size of aggregate is increased. The effect of wet-screening the larger sizes of aggregate and of curing conditions are also discussed.

TESTS OF MESNAGER HINGES 31-13

D. E. PARSONS and A. H. STANG — Jan.-Feb. 1935, pp. 304-325 (V. 31)

Hinges, (articulations) of the Mesnager type, consisting of crossed bars at a narrow gap in a reinforced concrete member, were analyzed and tested to determine the relations between forces and deformations and the stresses in the hinge bars. Formulas were developed for estimating the stresses and deformations caused by rotations and by compressive and shearing forces. Seven specimens, some with the hinge bars encased in mortar, were loaded to failure and their behavior compared with the calculated values.

CONCRETE — YESTERDAY, TODAY, TOMORROW 31-14

EDWARD J. MEHREN — Mar.-Apr. 1935, pp. 345-357 (V. 31)

Traces the steps by which concrete has won its way in the last 30 years and projects the curve of the significance by those years into a future of still greater accomplishment.

WHY CONTINUOUS FRAMES? 31-15

HARDY CROSS — Mar.-Apr. 1935, pp. 358-367 (V. 31)

A discussion of reasons for the development of continuous frames and a comparison with statically determinate analogues. The action of sections of reduced depth as hinges is discussed.

ARTICULATIONS FOR CONCRETE STRUCTURES — THE MESNAGER HINGE 31-16

B. MORRELL — Mar.-Apr. 1935, pp. 368-381 (V. 31)

Presents reasons for hinges or articulations in concrete structures and describes early attempts to articulate concrete arches, with examples. The development of the Mesnager hinge or "semi-articulation" is described as well as the tests made by the originator, the French engineer Augustin Mesnager, to verify his theories. Further tests made under the direction of the author are discussed and he furnishes a complete procedure for design of Mesnager type hinges.

AN INVESTIGATION OF THE PERMEABILITY OF MASS CONCRETE WITH PARTICULAR REFERENCE TO BOULDER DAM 31-17

ARTHUR RUETTGERS, E. N. VIDAL, and S. P. WING — Mar.-Apr. 1935, pp. 382-416 (V. 31)

The permeability investigation reported was made to provide data particularly applicable to the conditions at Boulder Dam, that is, for mass concrete exposed to a maximum hydrostatic head of over 700 ft, and made with special cement and 9-in. maximum size aggregate. The paper is comprehensive and includes (1) a description of the testing apparatus and technique, (2) the test results, (3) examples of the practical application of the investigational data, (4) a summary of results and conclusions, and (5) a discussion of the factors controlling the flow of water through concrete and the resultant corrosion.

PLACING CONCRETE BY MEANS OF VIBRATION 31-18

COMMITTEE 609 — Mar.-Apr. 1935, pp. 417-419 (V. 31)

Committee 609 progress report.

PRACTICAL APPLICATION OF VIBRATION 31-19

C. M. HATHAWAY — Mar.-Apr. 1935, pp. 420-423 (V. 31)

The use of mechanical vibrators in Illinois for placing concrete in the construction of bridges has had satisfactory results. Conclusions in regard to requirements of internal vibrators, preferable practices in their use, precautions in building forms, and permissible changes in the concrete mixes and their slumps are discussed in detail. The use of internal vibrators has cut down the cost of concrete structures by reducing the manpower required for spading concrete 40 to 70 percent and decreasing the required amount of cement 5 or 10 percent, although it requires an increase of 5 to 10 percent in the cost of form building.

An experiment in the use of surface vibrators on pavements is mentioned briefly. It was found that a leaner mix could be used and that a drier consistency was necessary. The pavement edges were, at times, honeycombed. Some surface scaling also developed, but it is uncertain whether this was due to the use of the surface vibrator.

VIBRATED CONCRETE IN PAVEMENT SLABS 31-20

F. V. REAGEL — Mar.-Apr. 1935, pp. 424-428 (V. 31)

Experiments indicate that the vibratory method of placement and finishing concrete pavements, with attendant savings in the cost of materials, is one of the most important recent developments in its field. Development of the equipment has lagged, however, so that maximum benefits are not yet available.

The two general types of vibrating equipment used in Missouri have produced good economical concrete pavement. Certain difficulties and limitations encountered are discussed without attempting to condemn or compare either type.

VIBRATION OF CONCRETE........31-21

W. R. JOHNSON — Mar.-Apr. 1935, pp. 429-431 (V. 31)

The selection of a vibrator to be used on a job is dependent on the type of form in which the concrete is being placed. Large open forms, using batches ranging from 2 to 6 cu yd, with aggregate graded up to 9-in. maximum size require a two-man vibrator. Thin walls and heavily reinforced sections should use internal vibrators operated by one man. Form vibrators are used where internal vibrators cannot be used, such as tunnel linings and concrete pipe. One vibrator will effectively handle from 12 to 36 cu yd per hr. Formwork need not be changed but should be made as tight as possible to prevent leakage. Drier concrete can be used when placing with vibration; sand in the mix can be reduced 2 to 4 percent. Determining the end point of vibration is a matter of experience which is soon acquired by the foreman or inspector. For measuring the effectiveness of equipment, work two or more vibrators of different type in the same form at the same time. Lower costs of vibrated concrete are due to saving in cement which amounts to one-half to one bag of cement per cu yd of concrete. The higher quality of concrete placed by vibration is due to drier mixes used, which means less free water, lower water-cement ratios, and less volume change.

CONSTRUCTION FEATURES OF THE ZEISS-DYWIDAG DOME FOR THE HAYDEN PLANETARIUM BUILDING 31-22

R. L. BERTIN — May-June 1935, pp. 449-460 (V. 31)

A brief history of the evolution of curved structures is given as an introduction to the description of the construction of the dome for the Hayden Planetarium. The Zeiss-Dywidag dome for the planetarium is a hemisphere, 8 ft 6 in. in diameter on the inside, the shell is 3 in. thick. In constructing the formwork, a self-supporting structure was adopted which would follow the geometrical characteristics of a sphere.

RECENT NOTEWORTHY DEVELOPMENTS IN CONCRETE'S USE IN HOUSING CONSTRUCTION 31-23

R. R. ZIPPRODT — May-June 1935, pp. 462-477 (V. 31)

Examples of the efforts of architects, builders, and owners to incorporate thoroughly fire resistant or completely fireproof construction in all types of residences in the Eastern seaboard area are given, with unit costs in many cases.

Several precast types of concrete construction, applicable to large-scale housing are also depicted.

The economic advantage accruing by the use of reinforced concrete structural frames and floors for multiple-unit housing projects, as evidenced by several major projects, is also presented.

STRUCTURAL AND ECONOMIC STUDIES OF MONOLITHIC CONCRETE WALLS FOR DWELLINGS 31-24

N. M. NEWMARK and R. E. COPELAND — May-June 1935, pp. 478-498 (V. 31)

A summary of studies concerning strength, design, and cost of formwork for monolithic concrete walls for dwellings, with particular emphasis on walls constructed of dry tamped concrete with sliding forms.

RECENT DEVELOPMENTS IN PRECAST JOIST RESIDENCE FLOOR CONSTRUCTION 31-25

W. G. KAISER, J. W. WARREN, F. N. MENEFEE, G. C. TURNER, HERMAN FRAUENFELDER, R. E. COPELAND, and C. V. BERRY — May-June 1935, pp. 499-512 (V. 31)

A symposium of five papers covering precast concrete joist floor construction, 1934-1935. Two papers are by joist manufacturers, reciting their experiences

in introducing precast concrete joists. A third is by a joist manufacturer describing construction of precast slab and precast joist floors for a Tennessee Valley Authority housing project. Two papers give results of tests by the University of Michigan and the Portland Cement Association Development Department to measure bond developed between precast joists and precast and job-placed slabs. Results showed such floors could be designed as T-beams.

ARCHITECTURAL CONCRETE MAKES PREFABRICATED HOUSES POSSIBLE. . 31-26

JOHN J. EARLEY — May-June 1935, pp. 513-526 (V. 31)

A description of the prefabricated concrete house built by the author's firm. Thin precast panels were used for walls, the rest of the house being conventional in design. Fabrication and construction procedures are given.

FREEZING AND THAWING, PERMEABILITY AND STRENGTH TESTS ON VIBRATED CONCRETE CYLINDERS OF LOW CEMENT CONTENT. 31-27

M. O. WITHEY — May-June 1935, pp. 528-538 (V. 31)

Data on the influence of external vibration in placing on the properties of over 200 concrete cylinders with cement contents between 3 and 4 sacks per cu yd and W/C ratios, by weight, between 0.50 and 0.77 are given. The advantages in using vibration in placing dry mixes of low cement content is indicated.

VIBRATION OF CONCRETE ON SAN FRANCISCO-OAKLAND BAY BRIDGE 31-28

THOMAS E. STANTON, JR. — May-June 1935, pp. 539-544 (V. 31)

Describes studies made by the California Division of Highways in 1932 on internal vibration of concrete and subsequent application of the results of these studies in drafting specifications for and the placing of concrete in the San Francisco-Oakland Bay Bridge, one of the earlier projects on which the internal type vibrator was used.

Some of the essential requirements and advantages of internal vibration in concrete construction are discussed. The paper includes a brief description of the 20 ft and 30 ft width pavement type vibrators used in placing and finishing the upper and lower roadways of the Bay Bridge.

VIBRATION AS AN AID IN PLACING BETTER CONCRETE 31-29

LEWIS H. TUTHILL — May-June 1935, pp. 545-550 (V. 31)

Particular emphasis is placed by the author on proper handling and placing of concrete to assure full benefit of vibration as an aid in placing the most efficient mix, i.e., one having the practical minimum water and cement content. Vibrators are most effective when used to consolidate a uniform concrete placed in a horizontal layer, but their effectiveness is considerably reduced when they must also transport and remix concrete in the forms.

HIGH FREQUENCY VIBRATION AS APPLIED TO THE CONSTRUCTION OF CONCRETE PAVEMENTS 31-30

F. H. JACKSON — May-June 1935, pp. 551-556 (V. 31)

Reviews the history of the development of high frequency vibration as applied to the construction of concrete pavements. Calls attention to the necessity of adjusting the consistency and the sand-coarse aggregate ratio if satisfactory results are to be secured and also to the fact that, if the maximum potential benefits resulting from vibration are to be realized, other units in the construction operation, such as mixer drum and conveyor bucket must be redesigned to handle much drier concrete than is at present possible.

MOSAIC CEILINGS, U. S. DEPARTMENT OF JUSTICE BUILDING 31-31

JOHN J. EARLEY — May-June 1935, pp. 557-564 (V. 31)

A description of the design and construction of mosaic ceilings. The impervious precast concrete slabs were used as forms into which the structural concrete was placed, saving the cost of wood forms and being more rigid than any wooden framework.

Proceedings V. 32

CEMENT AND CONCRETE CONTROL — SAN FRANCISCO-OAKLAND BAY BRIDGE 32-1

THOMAS E. STANTON, JR. — Sept.-Oct. 1935, pp. 1-27 (V. 32)

Describes the background of special cement specifications for the San Francisco-Oakland Bay Bridge in which moderate sulfate resistant (sea water) cement was used as a standard and a portland pozzolanic (high silica) type in portions of the structure.

Unique methods are described for control of (1) quality and uniformity of aggregates, (2) automatic batching, (3) transportation, and (4) placement to secure uniform concrete and uninterrupted progress of work. The author also describes design of the mix and methods of depositing concrete under water by specially designed buckets and in a tunnel by pumping.

ARCHITECTURAL CONSIDERATIONS IN BRIDGE DESIGN 32-2

MORRIS GOODKIND — Sept.-Oct. 1935, pp. 29-38 (V. 32)

Bridges are visible monuments to the culture and civilization of the periods which they represent. In addition to the utilitarian functions, bridges should reflect the artistic development of their period and beauty should be considered as a vital adjunct to structural analysis in their design. The engineer is not bound by any fixed standards or architectural forms, but may exercise his own talents and concepts in expressing the beautiful.

The paper discusses the basic considerations required in the architectural treatment of a bridge. Of prime importance is the expression of truth, so that the relationship of the structure to the obstacle which it crosses is apparent; the materials used are appropriate; surfaces, forms, and lines express the functions of design and characteristics of the materials. Simplicity applied to all elements rather than meaningless ornamentation of unimportant features will produce pleasing results.

Symmetry insofar as it is possible with the limitations of the site and harmony with the landscape, as well as between the component parts and materials, are essential. Proper proportion between individual members and their functions will produce attractive results and inspire confidence in the user. Preliminary studies of each structure should include architectural layouts and details at the inception of the design.

SUPERVISION AND INSPECTION OF CONCRETE 32-3

A. BURTON COHEN — Sept.-Oct. 1935, pp. 40-45 (V. 32)

Structural engineering is divided into three major branches — research, design, and construction. Inspection of concrete construction has not kept pace with research and design. A review of concrete research work since 1900 reveals extraordinary values, which have not been interpreted nor correlated to construction methods. Qualifications of an inspector indicate preference to technically trained men and effectiveness is dependent on a substantial knowledge of research and design.

CONCRETE SLABS REINFORCED WITH WELDED WIRE FABRIC 32-15

T. D. MYLREA — Nov.-Dec. 1935, pp. 219-227 (V. 32)

A series of tests on simple slabs and slabs with overhanging ends demonstrated that: (1) With cold drawn wire a working stress of 50 percent of the elastic limit as defined by ASTM is permissible. (2) Electric welding at intersections, if wires do not differ greatly in size, is not injurious. (3) Drooping of the reinforcement does not weaken the slab. (4) It is permissible to use clear spans in computing moments.

TEST OF COLORS FOR PORTLAND CEMENT MORTARS 32-16

RAYMOND WILSON — Nov.-Dec. 1935, pp. 228-229 (V. 32)

Exposure tests on portland cement mortars colored by the admixture of finely ground pigments are reported. Six months appears ample to indicate the color permanence of most pigments. Although most of the pigments tested were not affected by exposure to weather in the presence of portland cement, the use of color-durable pigments does not insure durability of color in the mortar surface. Exposure of the aggregate may lead to a change in color of the mass; another source of apparent color failure is efflorescence.

UNIFORMITY OF CONCRETE ON THE AVERAGE JOB — A STUDY OF 13,000 FIELD TESTS 32-17

HUGH C. ROSS — Jan.-Feb. 1936, pp. 277-284 (V. 32)

An analysis is presented of 13,000 concrete compression tests from 60 different job operations. The data show what variations in strength are likely to be encountered on the average job and the extent to which these variations are affected by the class of concrete involved. Curves illustrate how overdesigning will reduce the number of substandard tests and what margin of strength should be provided to meet given quality requirements.

CONCRETE AT NORRIS DAM 32-18

I. L. TYLER — Jan.-Feb. 1936, pp. 285-297 (V. 32)

A discussion of plant, construction procedures, and control methods used in building Norris Dam, Tennessee Valley Authority. The structure contained approximately 1,000,000 cu yd of concrete. Aggregates including sand were produced in six sizes from locally available dolomite rock. A modified portland cement was used. Particular attention was given to particle shape and grading of the sand. Concrete was mixed in 3-cu yd mixers and deposited by 6-cu yd bottom dump buckets, operating from two movable tower cableways. Close laboratory control of concrete was maintained.

A METHOD FOR DETERMINING THE AIR CONTENT OF FRESHLY MIXED MORTARS AND CONCRETES 32-19

J. C. PEARSON and H. G. COLLINS — Jan.-Feb. 1936, pp. 298-308 (V. 32)

This method involves the use of a pycnometer, or weighing pot, made of 5 in. diameter brass pipe, 14 in. high, in which a 10 to 15 lb sample of concrete is accurately weighed and its absolute volume accurately determined. The difference between the absolute volume and the bulk volume, as determined in the usual weight-per-unit-volume operation, gives the volume of entrained air. Calibrated weights and a sensitive balance of fairly large capacity are required.

ECONOMICS OF READY-MIX VERSUS JOB-MIX CONCRETE 32-20

R. L. BERTIN — Jan.-Feb. 1936, pp. 309-316 (V. 32)

This paper is presented as a general exposition of the application or use of both ready-mixed and job-mixed concrete from the standpoint of the contractor. The multiplicity of factors affecting the cost of producing concrete is such that it is impossible to give monetary data except for specific cases. This paper, therefore, is presented merely as a guide to assist the contractor in selecting the most advantageous method of supplying his job with concrete of required quality.

AGGREGATE PRODUCTION FOR GRAND COULEE DAM 32-21

GORDON F. DODGE — Jan.-Feb. 1936, pp. 317-332 (V. 32)

A description of aggregates used in the construction of the Grand Coulee Dam, the technical and mechanical problems that had to be solved during aggregate production and a description of the plant.

CONCRETE BY PUMP AND PIPELINE 32-22

CHARLES F. BALL — Jan.-Feb. 1936, pp. 333-349 (V. 32)

A description and explanation of the Pumpcrete (concrete pump) system with an analysis of the specific and unusual problems encountered in pumping plastic concrete mixtures, and the devices employed to meet these problems. A discussion of various mixtures that have been pumped, with some conclusions about concrete components and proportions that affect pumpability, is included.

SLABS SUPPORTED ON FOUR SIDES.32-23

J. DI STASIO and M. P. VAN BUREN — Jan.-Feb. 1936, pp. 350-364 (V. 32)

The basis of the ACI Building Regulations for slabs supported on four sides is covered in this paper. Factors of equivalent uniformly distributed loads are determined for use in calculating bending moments and shears in each direction of the slabs and supporting beams. With these factors, the design of slabs with any degree of rectangularity or variation in adjacent panels may be handled in the same manner as in one-way construction. A minimum thickness formula is established based on limiting deflection to definite ratios of the span consistent with all cases of rectangularity and continuity.

UNDERWATER CONCRETE MIXTURES AND PLACEMENT — SAN FRANCISCO-OAKLAND BAY BRIDGE 32-24

STANLEY M. HANDS — Jan.-Feb. 1936, pp. 365-377 (V. 32)

The foundation concrete for the San Francisco-Oakland Bay Bridge was placed in salt water at depths varying from 25 to 242 ft. There were 29 large seals involving from 5000 to 30,000 cu yd of concrete for each seal and requiring continuous operations for more than a week at a time. The submarine bucket, lowered with crane and hoist, was used to transfer the concrete from the mixer barges to the foundation at the greater depths. The tremie pipe was used in lesser depths. Concrete control and placement are described.

AT THE FORKS 32-25

P. H. BATES — Mar.-Apr. 1936, pp. 401-405 (V. 32)

Some suggestions are presented regarding the future activities of the American Concrete Institute. It is particularly recommended that greater activity on the part of committees be fostered.

BUILDING REGULATIONS FOR REINFORCED CONCRETE (ACI 501-36T) 32-26

COMMITTEE 501 — Mar.-Apr. 1936, pp. 407-444 (V. 32)

Superseded by 36-12

Proposed by Committee 501, Standard Building Code, the new "code" is here presented as revised and tentatively adopted at the 32nd Annual Convention, February, 1936.

RECOMMENDATIONS FOR PLACING CONCRETE BY VIBRATION 32-27

COMMITTEE 609 — Mar.-Apr. 1936, pp. 445-457 (V. 32)

The adoption of high frequency vibrators for placing concrete has been more rapid than the progress in acquiring basic information on such factors as frequency, amplitude, size of vibrator, type of vibrator, period and method of application and others. In this preliminary recommended practice for vibration, many of the requirements are based on the well established fact and principles of concrete making. Items covered include: type of vibrator, number and capacity, forms, adjustment of mix, vibrating procedure, and effects of vibration.

A STUDY OF THE ECONOMICS OF HIGH STRENGTH CONCRETE IN BUILDING CONSTRUCTION 32-28

F. E. RICHART — Mar.-Apr. 1936, pp. 459-472 (V. 32)

An analysis, using average current prices of concrete and steel, of savings to be effected by the use of high strength concrete in building construction. Studies of beams, slabs, flat slabs, columns, and footings are included. Considerable savings are theoretically possible in columns, smaller savings in flexural members, except as dead load can be reduced. While the greatest savings could be effected by using high strength concrete and higher steel stresses, the undesirability of the latter is discussed.

RECENT DEVELOPMENTS IN THE MANUFACTURE AND USE OF CAST STONE 32-29

C. G. WALKER — Mar.-Apr. 1936, pp. 473-484 (V. 32)

Relates experience and observations made in working with producers and users of cast stone. Problems of the material are studied and progress of the art recorded. Improvement in physical quality through specification of compressive strength is cited. Discusses exposed aggregate finishes, advantages of gap grading, automatic machine molding, vibration (also permitting polishing), cast stone as forms for structural concrete, homogeneous versus faced stone, and the various manufacturing processes.

TESTS OF THE RESISTANCE OF CONCRETE MASONRY WALLS TO THE PENETRATION OF RAIN......32-30

R. E. COPELAND and C. C. CARLSON — Mar.-Apr. 1936, pp. 485-494 (V. 32)

Leaky masonry walls persist today as one of the most perplexing problems in the construction of masonry structures. The research described herein on rain resistance of masonry walls has been broadly planned with regard to types of materials and construction. That part completed to date and which is briefly reported in this paper deals entirely with unpainted and painted walls of concrete masonry and has involved 45 different test specimens and a total of 91 tests. Recommendations are given for constructing leakproof walls.

ANALYSIS OF MULTIPLE SPAN RIGID FRAME BRIDGES BY THE SLOPE-DEFLECTION METHOD 32-31

GEORGE A. MANEY — Mar.-Apr. 1936, pp. 495-520 (V. 32)

Presents a concise analysis for one-, two- and three-span continuous concrete rigid frame bridges by an adaptation of the slope-deflection method. Several complete numerical solutions for the statically indeterminate moment distribution which results with rigid frame bridges made up of members having a variable moment of inertia are given using this method. An analysis is proposed based on the use of construction joints designed to eliminate the high stresses resulting from temperature changes and rib shortening in the multiple span cases.

CONCRETE RESTORATION IN WATER IMPOUNDING STRUCTURES 32-32

J. LAMPRECHT — May-June 1936, pp. 533-569 (V. 32)

Probably 95 of every 100 instances of concrete disintegration can be traced definitely to bad aggregate, bad mixing, or bad placing. Maintenance and restoration procedures are discussed in general and various methods are described which include the "plaster" method, gravity placed concrete, brush-applied cement-sand washes, and the "pressure-concrete" method. Other details covered are: proper base, mesh reinforcement, cracks and joints, mixes, aggregate, pressure for shotcrete finishing, curing, weeps, and integral waterproofing.

CONCRETE MAINTENANCE 32-33

L. F. HARZA and H. G. ROBY — May-June 1936, pp. 571-577 (V. 32)

Points out that maintenance and repairs to concrete structures which are suffering from disintegration of the concrete are often, if not usually, considered as a contracting problem rather than an engineering problem. Suggests that such problems should be carefully studied by engineers to insure that the repair work will prove satisfactory.

The repairs made in 1932 to the spillway of a dam constructed in 1922 are described. The spillway and the gate pier concrete was apparently placed without due care in mixing, stripping, gravel, borrow pits, placing, etc., and disintegrated badly in 10 years. A new concrete facing about 2 ft 8 in. thick was placed on the downstream side of the spillway, and the gate piers were replaced completely. The new spillway facing was reinforced by 1-in. round deformed bars on 12 in. centers both ways, 6 in. in from the surface. The new facing was anchored by 1 in. round dowels embedded 40 in. into the original structure. Bond between the old and new concrete was obtained by applying a plaster coat of 1:3 mortar on the old concrete. The mortar was thrown against the old concrete and then vigorously slapped by hand to cause the neat cement to penetrate into the old concrete. The repairs have proved satisfactory in all respects.

MAINTAINING CONCRETE STRUCTURES 32-34

FRANK W. CAPP — May-June 1936, pp. 579-592 (V. 32)

Deterioration of concrete structures due to (1) occluded water plus low temperature, (2) corrosion of reinforcing bars, and (3) unanticipated stresses is considered. The maintenance methods to be followed in dealing with the three causes of deterioration are outlined.

STUDYING THE DURABILITY OF CONCRETE 32-35

C. H. SCHOLER — May-June 1936, pp. 593-607 (V. 32)

A general discussion of the problem of concrete durability. The various components of concrete, the method of handling, placing, finishing, and curing, and the inter-relationship of these factors and the effects of each on the character of the concrete are considered.

Methods of studying durability in the laboratory and the field and some of the variables to be evaluated in such studies are briefly presented.

ALTERNATE HEATING AND COOLING OF MORTAR 32-36

E. R. DAWLEY — May-June 1936, pp. 609-620 (V. 32)

The effect of alternate heating and cooling, in water, on the compressive strength, length and weight of 3 x 6-in. mortar cylinders is reported for seven different brands of cement and three mixes. The first few cycles caused a sharp decrease in compressive strength after which there was either no change or some increase. The lengths and weights of all specimens increased. A cement which had excellent resistance to freezing and thawing had the least resistance to heating and cooling. As the

test progressed, the surface of the specimens checked, then cracked, and ridges of calcium carbonate formed on the cracks.

STUDIES OF HIGH-PRESSURE STEAM CURING OF CONCRETE SLABS AND BEAMS 32-37

CARL A. MENZEL — May-June 1936, pp. 621-640 (V. 32)

This third paper concludes the report on the investigation of high-pressure steam curing of concrete products (ACI Journal, Nov.-Dec. 1934, and Sept.-Oct. 1935). Two series of tests, one on solid slabs of plain concrete such as might be used in the manufacture of cast stone, and another series on the bond resistance of steel bars embedded in steam-cured and moist-cured concrete concluded the investigation.

Presents the results of both of these later series of tests and includes the results of recent tests of blocks tested at 1 year which formed the companion specimens of blocks and tested 7 days after steaming which were reported in earlier reports.

FACTORS OF WORKABILITY OF PORTLAND CEMENT CONCRETE. . . .32-38

W. H. HERSCHEL and E. A. PISAPIA — May-June 1936, pp. 641-658 (V.32)

On the thesis that workability cannot be expressed by a single numerical value, several new test methods have been devised. A test was developed for harshness (which measures the relative smoothness of an oversanded mix, compared to an undersanded mix), for segregation (which measures the separation of mortar when the concrete is jolted), for shear resistance (which measures the force required to shear the concrete) and for adhesion or "stickiness" (which measures the tensile strength of the concrete).

SOUND ABSORBING VALUE OF PORTLAND CEMENT CONCRETE . . .32-39

F. R. WATSON and KERON C. MORRICAL — May-June 1936, pp. 659-671 (V. 32)

An investigation of the sound absorbing values of concretes of different composition and physical properties. The results show that porous materials absorb sound, but dense materials with small porosity are not efficient in absorbing sound. Haydite and cinder concrete construction possess effective sound absorbing values; sand, gravel and limestone concretes were not so good, but most of the specimens were more sound absorbent than the usual hard plasters and cements.

HIGH EARLY STRENGTH CEMENTS IN CONCRETE MASONRY MANUFACTURE 32-40

COMMITTEE 710 — May-June 1936, pp. 673-680 (V. 32)

Committee 710 was organized in 1935 to study the use of high-early-strength cements in concrete products manufacture. This is a progress report and covers laboratory and plant tests on effect of grading of aggregate, kind of aggregate, volume change and resistance to freezing and thawing as influenced by the type of cement.

These tests indicate that for the method of curing used (3 days moist room, then air until test) 70 lb of high-early-strength cement gave compressive strengths higher than 94 lb of normal portland cement at ages of 3 to 28 days.

Proceedings V. 33

A STUDY OF REINFORCEMENT IN CONCRETE SLABS 33-1

INGE LYSE and GEORGE R. WERNISCH — Sept.-Oct. 1936, pp. 1-16 (V. 33)

Presentation is made of the results of an investigation of the use of different types and grades of reinforcing steel in 4 in. thick and 34 in. wide concrete slabs of various length and with different strengths of the concrete. The steel developed its full yield-point strength when flexure governed failure; the increase in the strength of the concrete did not materially increase the effectiveness of the reinforcement. The reinforcement was as effective in 16-ft spans as in 5-ft spans; size and spacing of steel did not influence the strength of the slabs; ordinary deformed reinforcing bars were as effective as welded wire fabric; and when reinforcement was stressed to 30,000 psi only hairline cracks appeared in the slabs and these cracks wholly disappeared when the loads were removed.

METALLIC AGGREGATE IN CONCRETE FLOORS 33-2

EDWARD W. SCRIPTURE — Sept.-Oct. 1936, pp. 17-27 (V. 33)

The requirements of metallic aggregate for use in concrete floors are given and good practice in laying floors with such aggregates is described. Methods and apparatus for measuring the resistance to abrasion and to impact are described. The results secured show the superiority of leaner mixes containing aggregate of larger maximum size, of metallic aggregate at the surface and of increasing the thickness of the metallic layer. Comparisons of mechanical floating and tamping are made.

EVALUATING FINES IN CONCRETE ON A BLEEDING TEST BASIS 33-3

J. C. SPRAGUE — Sept.-Oct. 1936, pp. 29-40 (V. 33)

Accelerated water-gain tests were made to determine the effect of various sub-sieve fines (including admixtures) on the capacity of concrete to resist bleeding, or rising of mixing water in the plastic mass, of concrete. During the progress of the program evidence was found which led to the belief that such a test could be adapted to one of the several facets of workability, viz., segregation. The method was found effective in evaluating the quantity of sub-sieve fines to use in concrete mixtures.

PROPERTIES OF JOB-CURED CONCRETE AT EARLY AGES 33-4

HARLAN H. EDWARDS — Sept.-Oct. 1936, pp. 41-64 (V. 33)

Job concrete characteristics vary with placing, temperature and curing conditions, though generally being superior to standard test cylinders if subject to adequate supervision. Floor slabs generally exceed walls and columns in strength tests. Variations occur in structures on directional exposures and vertically in rapidly placed walls and columns. Highway slab concrete characteristics vary with moisture and temperature and with color of curing media. Field-cured test specimens are generally unlike the structure. Tests of cores cut from structures provide accurate data and are economically possible. The report gives results of tests on specimens cured and cut from structures.

RESISTANCE OF CEMENT TO THE CORROSIVE ACTION OF SODIUM SULFATE SOLUTIONS 33-5

LEWIS H. TUTHILL — Nov.-Dec. 1936, pp. 83-106 (V. 33)

Describes investigations leading to preparation early in 1935 of one of the first (if not the first) consumer specifications for purchase of sulfate resisting cement. Cements of a wide range of compositions were tested. From evidence of their relative resistance to corrosion in sodium sulfate solutions, it appeared that a cement having a composition with maximum limits of 4 percent for C_3A, 12 percent for C_3A plus C_4AF, and 50 percent for C_3S would be highly sulfate resistant. Subsequent tests have proved cement manufactured under such a specification to be much more resistant to sulfate corrosion than cements of other composition.

EFFECT OF CALCIUM AND SODIUM CHLORIDES ON CONCRETE WHEN USED FOR ICE REMOVAL 33-6

H. F. GONNERMAN, A. G. TIMMS, and T. G. TAYLOR — Nov.-Dec. 1936, pp. 107-122 (V. 33)

Reports relative values of various types of surface coatings in preventing scaling of young concrete (12 x 12 x 2½-in. test slabs) when calcium and sodium chlorides were used for ice removal. Of the surface coatings tried, only two, linseed oil and soy bean oil, were of much value. The best surface coating consisted of boiled linseed oil thinned by an equal volume of turpentine, applied at the rate of about 50 sq yd per gal., followed after 24 hr by the application of straight boiled linseed oil at the rate of about 70 sq yd per gal.

EFFECT OF PLASTIC FLOW AND VOLUME CHANGES ON DESIGN... 33-7

COMMITTEE 313 — Nov.-Dec. 1936, pp. 123-128 (V. 33)

It is recognized that concrete changes in volume when subjected to stress (elastic deformation), sustained load (plastic flow), changes in moisture content (shrinkage), and temperature changes.

Formulas are given for estimating changes due to plastic flow and their effect on deflections, stress in the steel and stress in the concrete.

A CONDUCTOMETRIC ANALYSIS OF PORTLAND CEMENT PASTES AND MORTARS AND SOME OF ITS APPLICATIONS 33-8

W. B. BOAST — Nov.-Dec. 1936, pp. 131-146 (V. 33)

The purpose of this investigation was to develop conductometric methods for several problems related to portland cement pastes and mortars. Problems investigated include: (1) the setting phenomena during the first 3 hr; (2) the excess water tendency in sand-water mixtures; (3) measurement of internal stratification effects in cement pastes i.e., the relative vertical movement of constituents of a plastic mass as caused by capillary and gravitational forces, and (4) an attempted correlation of the electrical conductivity and the 28-day compressive strength of mortar mixes.

A SHORT METHOD FOR COMPUTING MOMENTS IN CONTINUOUS FRAMES 33-9

S. C. HOLLISTER — Nov.-Dec. 1936, pp. 147-169 (V. 33)

When the several members of a building frame are firmly connected to each other at the joints, stresses are set up in the members by live loads on adjacent members, as well as by loads on the members themselves. Unequal loads on adjacent spans, or equal loads on unequal adjacent spans, or some spans loaded with others not loaded, will greatly affect moments in the spans and will produce moments in intermediate columns. These moments, arising from action of the frame as a whole, are not determined by the usual moment coefficients. This paper furnishes a ready method for their approximate determination. It is based on the fundamental method of slope-deflections. Example problems and diagrams are included.

PORTLAND-POZZOLAN CEMENT AS USED IN THE BONNEVILLE SPILLWAY DAM 33-10

R. R. CLARK and H. E. BROWN, JR. — Jan.-Feb. 1937, pp. 183-221 (V. 33)

A description of concrete studies and construction of the Bonneville Dam. The method of construction consists of two principal steps in which one half is built in one working season between summer floods. There are about 500,000 cu yd of mass concrete and another 100,000 cu yd of reinforced concrete. Topics covered include cement investigation and selection, special cement specifications, concrete studies, stress analysis, and construction.

The investigation and use of portland-pozzolan cement for the dam is described in detail. Emphasizes the control of mass concrete from the design standpoint.

EARTHQUAKES AND REINFORCED CONCRETE 33-11

JACOB J. CRESKOFF — Jan.-Feb. 1937, pp. 223-249 (V. 33)

Investigates the distribution and frequency of earthquakes in the United States, theory of earthquake causation, nature and effect of earthquake vibrations on structures, statical and dynamical design of earthquake-resistant structures, and the characteristics of reinforced concrete which make it particularly suitable for use in earthquake-resistant construction.

MAINTENANCE AND REPAIR OF CONCRETE STRUCTURES IN RAILROAD CONSTRUCTION 33-12

M. HIRSCHTHAL — Jan.-Feb. 1937, pp. 251-278 (V. 33)

Begins by outlining the basis of the selection of concrete as a structural material from the viewpoint of railroad management shortly after the turn of the century — that concrete requires no maintenance; and then makes a comparison of structures built on the D.L.&W. Railroad between that time and 1916, with their condition 20 years later (1936) to evaluate the soundness of such conception. The conclusion from this comparison indicates that, while in this climate concrete definitely requires protection or maintenance as evidenced by these structures, 25 years of exposure have not undermined their integrity and that with but minor expense they have a long life ahead of them.

Traces the causes of deterioration between design and construction. Under design, aside from provision against stresses due to loads and soil bearing, the details for drainage, location of expansion and construction joints to compensate for volume and temperature changes; under construction, proportioning of concrete mixtures, selection of materials, workmanship of mixing and placing, and curing. Causes of failures are discussed in the description of the condition of the various structures.

Second section discusses methods of repair, describing four types (a) patching, (b) coating, (c) encasement, and (d) replacement of a part of or a whole member, and specifying the methods of such work.

Summarizes in conclusion the causes of cracks and deterioration, listing these between (a) structural and (b) installation — materials and methods; followed by a list of precautions to be taken when making repairs. An appendix giving "specifications for concrete repair work" is included.

CEMENT AND CONCRETE STUDIES ON THE PASSAMAQUODDY TIDAL POWER PROJECT 33-13

HUGH J. CASEY — Jan.-Feb. 1937, pp. 279-302 (V. 33)

Incident to the determination of the type cement and aggregates to be employed on the Passamaquoddy Tidal Power Project, extensive investigations and concrete laboratory tests were made of 45 different cements and 54 sources of aggregate. The type cements tested were standard portland high-early-strength, alumina, portland-pozzolan, synthetic pozzolan, natural, and blended cements. The concrete in this structure was to be subject to exceptionally severe attack from (a) salt water, (b) semi-daily alternate wetting and drying within the tidal fluctuations of 18 ft mean and 27 ft maximum range, and (c) severe freezing, including frequent alternation of freezing and thawing cycles. Laboratory tests, supplemented by certain field tests, covered cement characteristics, effect of salt water on mixing and curing, heat of hydration, effect of fineness of grinding, magnesium sulfate test on effect of C_3A content, bleeding, optimum mixture, volumetric change, modulus of elasticity, freezing and thawing, thermal flow, flexural strength, and

curing procedure for mass concrete. In general the findings indicated that a portland cement of medium high fineness (1800-2300 sq cm per g) and low C_3A content was satisfactory, whereas similar portland cements of high C_3A content were less resistant to salt water and alternate freezing; the high-early-strength cements were satisfactory except for problem of heat dissipation; natural cement was weak in slow rate of setting and in low strengths; alumina cement was excellent except for heat dissipation in mass setting; the portland-pozzolan and blends of portland and natural cements showed poor resistance to alternate freezing and thawing. Detailed tabulations and findings are covered in this paper, including characteristics of the cement considered most suitable.

CONCRETE REHABILITATION WORK ON THE UNCOMPAHGRE PROJECT . . 33-14

A. B. REEVES — Jan.-Feb. 1937, pp. 303-310 (V. 33)

The South Canal extending from the outlet of Gunnison Tunnel to the Uncomphagre River in western Colorado is one of the principal features of the Uncompahgre Project of the Bureau of Reclamation.

Most of the concrete lined channel had ½ to 1 side slopes, 6 in. thick. Approximately one half of the lining was reinforced. This canal was constructed in 1906 and 1907, and specifications for the concrete work were in accordance with standards of that period. This resulted in a permeable and low grade of concrete as compared to present day requirements.

During 30 years of operation a good many failures had occurred due to (1) disintegrating action of alkali, believed to be contributed by the underlying shale material; (2) settlement of foundation; (3) swelling of shale under the lining; (4) hydrostatic pressure under the lining; and (5) weathering including frost action.

This canal was rehabilitated during the nonirrigation seasons, (November to March) from 1934 to 1937. In places where the old concrete was badly broken up, a new lining of reinforced concrete approximately 6 in. thick was placed inside the old channel, care being taken to secure bond and anchorage to the old lining wherever possible. Modern standards of concrete construction were carried out resulting in compressive strength averaging 5500 psi for test cylinders 28 days old. Particular attention was given to finish to secure a low friction coefficient thus maintaining the capacity.

Where the lining was badly cracked but still in place and held together by the reinforcement, the method of repair was to cover the entire surface with shotcrete. The shotcrete layer is from 0 to 4 in. thick reinforced with bars at 12 in. both ways. Care was exercised to insure a clean surface for the shotcrete, and to secure a bright glazed surface which has a good roughness coefficient.

Bulged floors in the tunnels were repaired by replacement of the old concrete by a new section with a curved invert, thus eliminating the necessity for reinforcement.

A STUDY OF THE COLUMN CHAPTER OF THE ACI BUILDING REGULATIONS FOR REINFORCED CONCRETE 33-15

C. A. WILLSON — Jan.-Feb. 1937, pp. 311-317 (V. 33)

Spiral column design according to the 1936 Tentative Standard Building Code is compared with former specifications and the following weaknesses are pointed out and discussed: the radical increases in allowable safe load and amounts of vertical and spiral steel, and the lack of experimental data to justify the loading of the fireproofing shell.

GRADING AND WORKABILITY 33-16

W. H. GLANVILLE — Jan.-Feb. 1937, pp. 319-326 (V. 33)

Summarizes the results of work done at the Road Research Laboratory, Harmondsworth, Middlesex, England. The theoretical aspects of workability are discussed and a definition of workability given. A method of test, the compacting factor test, is described which measures the degree of compaction of concrete after a standard amount of work has been done on it and relating this to the density of fully-compacted concrete. Using this test, the relation has been established between the strength and workability for mixes of various proportions and various water-cement ratios. The grading and shape of the aggregate have also been considered in relation to the effect on workability and strength. The results of the investigations are summarized in tables, which show the water-cement ratios necessary to give three different degrees of workability in concretes having proportions ranging from 1:3 and 1:7½ by weight, with each of four different aggregate gradings. A table is presented showing the suitability of different aggregate gradings for various mixes according to the degrees of workability required. Some indication is also given of the effect of dust in the aggregate on the workability of the concrete.

DRYING SHRINKAGE OF LARGE CONCRETE MEMBERS 33-17

ROY W. CARLSON — Jan.-Feb. 1937, pp. 327-336 (V. 33)

A few test data are offered to show the exceedingly slow rate of penetration of drying shrinkage into a mass of concrete. From these data, support is obtained for the view that the loss of moisture from concrete can be computed by applying the laws of diffusion, just as the loss of heat from a cooling body is computed. For a typical case, drying is shown to penetrate only about 8 in. into a mass of concrete after a full year of continuous drying at 50 percent relative humidity. Substantially no moisture is shown to be lost beyond the depth of 8 in. at the end of the year.

A STUDY OF SUBAQUEOUS CONCRETE 33-18

ARTHUR R. ANDERSON — Jan.-Feb. 1937, pp. 339-346 (V. 33)

A comparison of two methods of placing underwater concrete, the tremie method and drop-bottom bucket method. The strengths of the tremie concrete are compared with similar concrete deposited in air under standard control conditions. The effect of grading of aggregates, quality of cement and workability on subaqueous concrete was also studied. The strengths obtained from subaqueous concrete were lower than the strengths obtained from the same concrete not deposited under water. On an average, tremie concrete was 17 percent stronger than concrete placed with a drop-bottom bucket.

THE INSTITUTE CARRIES ON 33-19

F. R. McMILLAN — Mar.-Apr. 1937, pp. 363-366 (V. 33)

Retiring President McMillan cites the difficulties of ACI during the period of the depression and points out some of the fields in which the Institute can enlarge its usefulness.

CONCRETE: ITS MAINTENANCE AND REPAIR 33-20

R. B. YOUNG — Mar.-Apr. 1937, pp. 367-393 (V. 33)

Maintenance and repair have much in common and in many cases it is difficult to say whether the remedial work being done is one or the other. In any case, the difference is largely one of degree and the methods are essentially the same. The paper makes no attempt to separate the two, for the principles underlying both maintenance and repair work are the same and similar methods and materials are used.

Author classifies the various methods under the headings of surface treatments, waterproofing, pointing and caulking, patching, surfacing with mortar coatings, and replacement; he then discusses each method in detail and describes some typical repair and maintenance jobs.

SOME COMPARISONS OF EUROPEAN AND AMERICAN CONCRETE PRACTICES 33-21

F. R. McMILLAN —Mar.-Apr. 1937, pp. 395-410 (V. 33)

Illustrated descriptions are given of various typical European structures including bridges, dams, and water tanks.

THE EFFECT OF VIBRATION ON THE STRENGTH AND UNIFORMITY OF PAVEMENT CONCRETE 33-22

F. H. JACKSON and W. F. KELLERMANN — Mar.-Apr. 1937, pp. 411-432 (V. 33)

Tests were made on full size pavement slabs, using regular construction equipment. Several well-known types of high frequency surface vibrators were investigated. Major indications were (1) that with equal cement contents, vibration increased flexural strength about 10 percent, (2) that, with equal water-cement ratios, vibration effected a saving in cement of about 10 percent and (3) that the uniformity of pavement concrete of 1-in. slump was markedly improved by the application of surface vibration.

THE NEW FEDERAL SPECIFICATIONS FOR PORTLAND CEMENTS 33-23

BEN MOREELL — Mar.-Apr. 1937, pp. 435-455 (V. 33)

Gives the history of development of American portland cement specifications and reasons for development of the new Federal Specifications for "nonstandard" portland cements. He describes the principal features of the four new specifications for normal portland cement, high-early-strength cement, moderate heat of hardening cement, and sulfate-resisting cement and discusses practical features of manufacture and use of the new cements.

RAPID AND LONG-TIME TESTS ON REINFORCED CONCRETE KNEE FRAMES 33-24

F. E. RICHART and T. A. OLSON — Mar.-Apr. 1937, pp. 459-479 (V. 33)

The tests reported are a part of an investigation of rigid frame bridges made at the University of Illinois. The knee-frames were designed to represent a portion of the rigid frame bridges at the junction of the vertical and horizontal members. Various types of fillets were used at the inside corner of the frame, and the effect of compression reinforcment was studied. Part of the frames were held under sustained load for 15 months. To supplement the tests, photoelastic studies on scale models of bakelite were also made and the results compared with those from the structural members.

DESIGN OF REINFORCED CONCRETE MEMBERS UNDER FLEXURE OR COMBINED FLEXURE AND DIRECT COMPRESSION 33-25

CHARLES S. WHITNEY — Mar.-Apr. 1937, pp. 483-498 (V. 33)

Presents a rational method for the proportioning of arch ribs, rectangular columns under eccentric load, and beams which recognizes the plasticity of the concrete and its effect on the stress-strain relationship. Formulas are given which predict the ultimate strength of members based on the cylinder strength of the concrete and yield strength of the steel independent of the ratio of their moduli of elasticity.

HIGH EARLY STRENGTH CEMENT IN CONCRETE MASONRY MANUFACTURE 33-26

COMMITTEE 710 — Mar.-Apr. 1937, pp. 499-502 (V. 33)

Tests to determine the effect on durability of the reduced cement content when using high-early-strength cement are reported. The tests on freezing and thawing show that the reduced cement content does not reduce the resistance to freezing and thawing; the investigation of volume changes indicate that there is practically no difference between the shrinkage of high-early-strength cement concretes and normal cement concretes. The aggregate, however, had a marked effect.

BUILDING REGULATIONS FOR REINFORCED CONCRETE 33-27

COMMITTEE 501 — Mar.-Apr. 1937, pp. 503-504 (V. 33)

A progress report of Committee 501.

NOTES ON INSPECTION OF STRUCTURES IN EUROPE 33-28

A. J. BOASE — May-June 1937, pp. 521-540 (V. 33)

Construction and trade practices in England, France, Germany, Switzerland, and Denmark are depicted. Particular attention is given reconstruction of the Havre pier by Freyssinet, employing "treated concrete" (proper mix, vibration, pressure, prestressed steel) and other of his unique developments. Long-span hollow-membered bridges, continuity in building frames, thin walls in industrial and commercial buildings, and shell construction contrast European and American engineering practices. System of contracting and laws peculiar to Europe are compared with those of America, accounting for cost differences.

RECENT DEVELOPMENTS IN FOUNDATION DESIGN — WITH SPECIAL REFERENCE TO CONCRETE 33-29

CARLTON S. PROCTOR — May-June 1937, pp. 541-556 (V. 33)

Describes, illustrates, and explains the following foundations employing new design principles.

(1) The San Francisco-Oakland Bay Bridge, where the Moran and Proctor caisson provided pneumatic false bottoms, maintained at desired levels above caisson cutting edge by hemispherical domes capping air filled cylinders. An explanation is presented for the reversal of usual principles of design and construction of bridge piers in water depths considerably greater than previous limits; also reversal of economics since older types involve rapid increases in cost as flotation depth increases, whereas this caisson reduces in cost where dredging depth decreases as a result of flotation depth increase.

(2) Foundation and grading treatment at Flushing Meadows, to create site for New York World's Fair, involving new principles for eliminating mud waves and for loading and filling on highly fluid silts.

(3) Mississippi River bridge at New Orleans, employing newly-designed thin exterior caisson walls incorporating cutting and bathing jets; also provision that portions of caisson walls be unfilled above caisson seal to reduce bearing intensities.

(4) Deep reinforced concrete annular girder foundations for support of tower structure for Palace of Soviets, Moscow, where superstructure steel skeleton consists of single two-leg columns on perimeter of tower base, without interior columns. The diameter of circle of columns is 148 m. Columns are set in from vertical around hemispherical auditorium dome, thus requiring that there be no differential settlements between columns to cause departure of column base levels from a plane.

RECENT DEVELOPMENTS IN PILE FOUNDATIONS 33-30

MAXWELL M. UPSON — May-June 1937, pp. 557-574 (V. 33)

Presents a resume of the most recent developments in piles for foundations and dikes. Describes the various piles available and the special advantages of each. Particular attention is given to the new types of cast-in-place concrete piles and special provisions for piles of long length. Also describes

the new type of concrete sheet pile dike and concludes with a resume of various measures for salt water protection of precast piles.

PROPERTIES OF CEMENTS AND CONCRETES CONTAINING FLY ASH 33-31

RAYMOND E. DAVIS, ROY W. CARLSON, JOE W. KELLY, and HARMER E. DAVIS — May-June 1937, pp. 577-612 (V. 33)

Presents results of extensive tests to determine the feasibility of using various fly ashes with various types of portland cement. (Fly ash is the residue from burning powdered coal, caught by precipitators). Properly constituted fly ash is an excellent pozzolan. Tests to determine water requirement, strength, volume change, heat of hydration, resistance to freezing and thawing, and resistance to sulfate action indicate that fly ash of moderately low carbon content and moderately high fineness can be advantageously used in percentages up to 30 for ordinary construction and in percentages up to 50 for heavy construction. Suggested specification requirements for fly ash are given.

EXPERIENCES OF AN AMERICAN CONTRACTOR IN LONDON, ENGLAND 33-32

JOHN G. AHLERS — May-June 1937, pp. 613-624 (V. 33)

A narrative of construction problems in London, England, 1935-1936.

Proceedings V. 34

RECTANGULAR CONCRETE SECTIONS UNDER TORSION 34-1

PAUL ANDERSON — Sept.-Oct. 1937, pp. 1-12 (V. 34)

Most concrete members in bridges and buildings sustaining torsion are of rectangular section, the torsional strength of which is most efficiently raised by 45 deg spirals. This paper reports the data obtained by subjecting 24 rectangular concrete specimens to torsional moments of increasing magnitude until failure. These data form the basis for a study of stress distribution, modulus of elasticity in shear, and ultimate strength.

Of importance to the designer is the conclusion that the ultimate strength of a spirally reinforced section can be approximated from the strength of the plain concrete section and the amount of reinforcement.

THE AUTOCLAVE TEST AND INTERPRETATIONS 34-2

ROY N. YOUNG — Sept.-Oct. 1937, pp. 13-24 (V. 34)

The autoclave test is described as an indicator of expansive properties of cements. Data and descriptions of tests on hydration of free lime and magnesia in cements, and the relation of contraction to high C_3A content in cements, are presented.

Many commercial cements do not follow general trends indicated by data on C_3A content. The use of the autoclave test for purpose of eliminating rare cases of excessive concrete expansion appears justified.

LENGTH CHANGES OF CEMENT PASTE IN RELATION TO COMBINED WATER 34-3

YASHICHI YOSHIDA — Sept.-Oct. 1937, pp. 25-44 (V. 34)

Volume changes resulting from moisture changes in concrete are correlated with changes in water paste. Tests and results on fixed water, nonfixed water, hydrolysis and hydration are included. Relation of compressive strength to water of hydration and hydrolysis is shown and determinations of water content and combined carbon dioxide content of hardened cement paste are recorded.

MEASUREMENT OF THE MOISTURE CONTENT OF CONCRETE 34-4

R. W. SPENCER — Sept.-Oct. 1937, pp. 45-64 (V. 34)

Resistance test measurements of moisture content of concrete are described, methods and results noted. Calibration chart shows relation between moisture loss in concrete and the ratio of the percent of conductance of field concrete to that of control concrete. Tests of slabs in the Colorado River Desert, Morris Dam mass concrete, and tunnel lining of Mecca Pass Tunnel of the Colorado River Aqueduct are recorded, indicating moisture content variation of structures in the field.

A SIMPLE TEST FOR WATER PERMEABILITY OF CONCRETE 34-5

GEORGE WILEY and D. C. COULSON — Sept.-Oct. 1937, pp. 65-76 (V. 34)

Object of studies and tests described was: to develop a simple, inexpensive method for determining permeability; to prove the method by determining the effect of variables which have been adequately studied previously; to investigate the effects of cement fineness on permeability; and to investigate the effect on permeability of using a cement ground with a dispersing agent (TDA). Tests and data indicate effect on permeability of water-cement ratio, cement fineness, curing conditions, and dispersing agents.

A SIMPLE METHOD FOR THE COMPUTATION OF TEMPERATURES IN CONCRETE STRUCTURES 34-6

ROY W. CARLSON — Nov.-Dec. 1937, pp. 89-104 (V. 34)

Thermodynamics of temperature change is discussed and equations are developed. Tabular method of solution of equations is shown, with applications of special cases. Tabular method is compared with precise calculations, and value of temperature computation is cited.

CALCULATION OF TEMPERATURE DISTRIBUTION IN A SUCCESSION OF LIFTS DUE TO RELEASE OF CHEMICAL HEAT 34-7

ROBERT E. GLOVER — Nov.-Dec. 1937, pp. 105-116 (V. 34)

Exact and rapid calculations of temperature distribution in successive lifts are obtained by synthesis from Kelvin's instantaneous surface source. Integrals are arranged for graphical evaluation with the aid of a planimeter. A mathematical device is introduced to simplify and expedite the graphical work. The first part of the paper deals with diffusion of the heat previously generated, the second accounts for heat released by chemical action, and a third part deals with the effect of external temperature changes.

MEASURED AND COMPUTED TEMPERATURES OF CONCRETE AT NORRIS DAM 34-8

DOUGLAS McHENRY — Nov.-Dec. 1937, pp. 117-128 (V. 34)

Measured and computed temperatures of the interior of Norris Dam are recorded. Assumptions used in computation are noted, and the simplified method is justified. Temperature history and temperature distribution for portions of the dam are recorded graphically.

CLASSIFICATION OF ADMIXTURES AS TO POZZOLANIC EFFECT BY MEANS OF COMPRESSIVE STRENGTH OF CONCRETE 34-9

F. R. McMILLAN and T. C. POWERS — Nov.-Dec. 1937, pp. 129-144 (V. 34)

Strength test data are used to indicate the effect of the following admixtures: bentonite, Tripoli silica,

California pumicite, diatomaceous earth, crystalline talc, hydrated lime, Kansas pumicite, Magnolia cement, blast furnace slag, and hydraulic lime. Strength is considered as an index to pozzolanic action, and sample analysis of data is given in an appendix.

BOND STUDIES OF DIFFERENT TYPES OF REINFORCING BARS 34-10

GEORGE ROBERT WERNISCH — Nov.-Dec. 1937, pp. 145-164 (V. 34)

Results of bond tests on 148 6 x 6-in. cylindrical pull-out specimens and 58 6 x 12 x 36-in. beams (nominal effective depth 9.0 in.) containing 13 types of ½- and ¾-in. diameter reinforcing bars are reported.

Pull-out test seems a poor measure of bond resistance of reinforcing bars placed in beams of the dimensions noted, both in initial and ultimate end slip. Type of bar has a marked effect on the resistance of bars subjected to a pull-out test, whereas, with the exception of threaded and smooth bars, the type of bar has slight influence on bond resistance of the bars embedded in beams. Increasing strength of concrete usually results in a moderate increase in bond resistance of both beams and pull-outs, not in direct proportion to increase concrete strength. Initial slip in beams occurs at a much greater calculated bond stress than in pull-out tests. Commercial bars are stronger than ordinary plain bars in bond resistance determined by beam tests.

SHEARING DEFORMATION IN CONTINUOUS BEAMS AND RIGID FRAMES 34-11

A. FLORIS — Nov.-Dec. 1937, pp. 165-192 (V. 34)

Deformation methods used in analysis of continuous beams and rigid frames do not consider the influence of shearing forces. Ordinarily this influence is negligible. However, cases may arise in practice where the deformation due to the shearing forces cannot be neglected. A means of including shearing force influence in the slope-deflection and moment distribution methods is outlined. Equations are developed, and extensive examples of analysis both with and without shearing effect are furnished.

LIGHTWEIGHT CONCRETE PAVEMENT ON THE SAN FRANCISCO-OAKLAND BAY BRIDGE 34-12

GLENN B. WOODRUFF — Jan.-Feb. 1938, pp. 225-240 (V. 34)

Upper deck of the San Francisco-Oakland Bay Bridge, restricted to light traffic (H-10 loading) is made of lightweight "gravelite" slab to reduce dead load. Design of slab aggregate specifications, construction methods, and service record after a year of operation are discussed. Cost of materials is recorded and absence of cracks noted.

THE ACTION OF SULFATE SOLUTIONS ON STEAM-CURED COMPOSITE CEMENT MORTARS 34-13

T. THORVALDSON and D. WOLOCHOW — Jan.-Feb. 1938, pp. 241-268 (V. 34)

Comparison is made between the behavior of untreated and steam-cured specimens of concrete in sulfate solutions. Includes a report on tests of steam-cured composite cement mortars, and experimental results. Steam curing causes the first reaction in each case to proceed almost to completion with the formation of crystalline $C_3A \cdot 6H_2O$, and partial or complete removal of free lime by combination with silica sand and depending on the quantity of C_3S present.

EFFECT OF TYPE OF TEST SPECIMEN AND GRADATION OF AGGREGATE ON COMPRESSIVE STRENGTH OF CONCRETE 34-14

TIBOR GYENGO — Jan.-Feb. 1938, pp. 269-284 (V. 34)

The specifications for test specimens in various countries are given. Results of test to determine the effect of type of test specimen and gradation of aggregate on compressive strength are noted. Specimens tested include different size cubes, prisms with variable slenderness, and cylinders. Comparison of 28-day compressive strengths of specimens having equal slenderness and ratio and size indicates strengths practically equal. Studies made also include relationship between strength and fineness modulus.

DETERMINING CONCRETE STRENGTH FOR CONTROL OF CONCRETE IN STRUCTURES 34-15

B. G. SKRAMTAJEW — Jan.-Feb. 1938, pp. 285-304 (V. 34)

Good concrete control methods require testing concrete in the finished structure as well as the usual specimens made at the time of placing. Fourteen methods of testing concrete in the finished structure are described, half of them requiring preliminary measures when placing the concrete. These tests are much more cumbersome than the other half which may be performed any time at any point. It is suggested that both types be used together.

VACUUM CONCRETE 34-16

WILLIAM F. LOCKHARDT — Jan.-Feb. 1938, pp. 305-320 (V. 34)

The vacuum process provides a practical means of obtaining concrete with minimum water-cement ratio. It removes unwanted mixing water from the concrete after it has been placed in the forms. Process is described, and application to floors, walls, bridge decks, and various surfacing and resurfacing projects are enumerated.

FLAT SLABS AND SUPPORTING COLUMNS AND WALLS DESIGNED AS INDETERMINATE STRUCTURAL FRAMES 34-17

HENRY D. DEWELL and HAROLD B. HAMMILL — Jan.-Feb. 1938, pp. 321-344 (V. 34)

A study of the practicability of treating the design of flat slabs and their supporting columns and walls as indeterminate structural frames, this paper was written in connection with the formulation of the Uniform Building Code — California Edition. It includes a general discussion of existing building code provisions and presents an analysis of flat slab construction by "elastic frame" method.

Diagrams for moment coefficients for maximum positive slab moments in interior and exterior panels and columns are presented, and examples of the application of curves for column moments to specific cases are given.

CIRCULAR FLAT SLABS, WITH CENTRAL COLUMN 34-18

JOSEPH A. WISE — Jan.-Feb. 1938, pp. 345-352 (V. 34)

Analysis and design of large diameter circular roof slabs for cylindrical underground tanks and reservoirs having central column supports are developed. Curves for radial moments, moments at edge of column capital, tangential movements, and column loads are given, and use of the curves is illustrated by a typical example.

A REDUCTION METHOD FOR THE ANALYSIS OF CONTINUOUS BEAMS AND OPEN FRAMES 34-19

MIKLOS HETENYI — Jan.-Feb. 1938, pp. 353-364 (V. 34)

Continuous beams and frames are reduced to simpler form, moments over loaded part of this form are computed and moments obtained are distributed among adjoining members, and a moment diagram for the entire structure is secured. Tables are given showing formulas of reduction and rules of moment distribution. Application of the method to a rigid frame structure is given, showing completed moment diagrams with and without sidesway.

FUTURE POLICIES OF THE INSTITUTE 34-20

J. C. PEARSON — Mar.-Apr. 1938, pp. 377-380 (V. 34)

President Pearson points out that the trend of papers published in the Journal is toward the more academic and highly technical type, with the result that many members concerned with actual making of concrete find less of interest in the Journal and in the Institute itself. Broadening the Institute's objectives and service are recommended as a means of increasing its influence. A Journal section for open-forum discussion is suggested.

FACTORS WHICH INFLUENCE THE DURABILITY OF CONCRETE STAVE SILOS 34-21

DALTON G. MILLER — Mar.-Apr. 1938, pp. 381-400 (V. 34)

Effect of weathering and silage action on some 200 masonry silos in Iowa, Minnesota, South Dakota, and Wisconsin is reported, based on field investigation. Silage action is described in detail. Tests of the 1350 silo staves collected from nine different plants also are reported. Tests include determination of effect of cement factor on strength and absorption of staves, relation of permeability and absorption to strength of staves, and the effect of number or tamps.

THE RESISTANCE OF REINFORCED CONCRETE COLUMNS TO ECCENTRIC LOADS 34-22

F. E. RICHART and T. A. OLSON — Mar.-Apr. 1938, pp. 401-420 (V. 34)

In view of a large variation in "n", current "exact" column analyses and design charts are examined. Simplified methods of design for members under combined axial and bending load are proposed. University of Illinois tests, 1936 series, are recorded; effectiveness of protective shells and effect of axis of loading are discussed.

Previous tests by Bach and Graf in Germany, Wisconsin tests, and Illinois 1925 tests are reviewed. Charts and tables for the simplified analysis and design are presented.

CONSTRUCTION OF THE SAN JACINTO MEMORIAL 34-23

C. A. BULLEN — Mar.-Apr. 1938, pp. 421-432 (V. 34)

Describes the San Jacinto Memorial tower, an octagonal shaft 570 ft high of reinforced concrete faced with stone. Construction details including use of stone facing for outside form are discussed. A large 34-ft high star of structural steel, concrete, and stone on the top of the shaft, presented unique construction problems which were overcome by a special mast and boom, taken up and removed inside the tower, and 90 ft of tubular tower erected on cantilever beams outside the main tower.

RESISTANCE OF CEMENTS TO ATTACK BY SEA WATER AND BY ALKALI SOILS 34-24

THOMAS E. STANTON, JR. and LESTER C. MEDER — Mar.-Apr. 1938, pp. 433-464 (V. 34)

Premature disintegration of California pavements occasioned investigation of alkali soils and their effect on concrete. Analysis of alkali content of several California soils are presented. Test specimens made with 11 cements commercially available in California were subjected to varying degrees of exposure to sea water and alkali soils. Compressive strengths and weight losses are recorded, indicating effect of chemical composition of cement on alkali resistance. Specific results apply to California cements, but major trends should be of general interest.

REINFORCED CONCRETE DESIGN PRACTICE 34-25

ALBERT SMITH — Mar.-Apr. 1938, pp. 465-472 (V. 34)

Twenty-one Chicago engineers report their agreement on design practice for footing base slabs, footing caps, length of column dowels, offset vertical steel of columns, inclined stirrups, and shrinkage prevention. Agreement is recorded on a number of other design practices which fall beyond the limits of the ACI building code.

PROBLEMS INVOLVED IN MASS CONCRETE CONSTRUCTION AND METHODS OF ATTACK BY THE COMMITTEE 34-26

RAYMOND E. DAVIS — Mar.-Apr. 1938, pp. 473-476 (V. 34)

Mr. Davis' remarks introduced a session on mass concrete at the 34th annual convention in Chicago, 1938. He reviews briefly progress in the field of mass concrete from 1930 to 1938, indicates the efforts of Committee 108, and suggests that much remains to be learned about mass concrete action.

CRACKING IN MASS CONCRETE . . . 34-27

R. F. BLANKS, H. S. MEISSNER, and C. RAWHOUSER — Mar.-Apr. 1938, pp. 477-496 (V. 34)

Includes descriptive matter and tests on the cause and control of cracking, temperature variation, and thermal stress and volume change, based on design and research work of the Bureau of Reclamation. Structures studied include Owyhee, Boulder, Grand Coulee, Norris, Bartlett, and Morris dams and other smaller dams. Shrinkage studies of test bars and cylinders are described and results indicated. The most effective single method for improving cracking conditions is the use of low-heat or portland-pozzolan cement.

TEMPERATURES AND STRESSES IN MASS CONCRETE 34-28

ROY W. CARLSON — Mar.-Apr. 1938, pp. 497-516 (V. 34)

Interior and boundary temperature changes are considered separately. Interior temperature distributions are plotted to show effect of time, thickness of lift, type and quantity of cement, and precooling. Surface temperature effect on boundary concrete is shown. Simplified methods of computing both horizontal and vertical stresses due to temperature change are given, and value of thermal stress analysis is discussed. Factors producing favorable temperature in mass concrete are listed as low heat cement, low cement content, low casting temperature, shallow lifts and regularity of casting.

NOTES ON EXISTING RIGID FRAME BRIDGES IN THE UNITED STATES . . . 34-29

D. H. PLETTA — Mar.-Apr. 1938, pp. 517-524 (V. 34)

Presents a report on the number and type (slab or ribbed deck, single or multispan, etc.) of rigid frame bridges built in the United States from 1922 to 1936. Variations in design constants are noted and some unusual features discussed. Information was gathered from state highway departments. An extensive bibliography is included.

A CHALLENGE — SHORTEN THE LAG BETWEEN RESEARCH AND PRACTICE 34-30

FRANK T. SHEETS — May-June, 1938, pp. 541-548 (V. 34)

The time elapsing between the findings of research and their general acceptance and application by engineering practitioners is one of the great ills of the engineering profession. Lack of interpretation and lack of selling of the fruits of research are advanced as the primary cause of the ill. The cure is dependent on a frank analysis of the existing situation, correction of present evils, and development of improved procedure. Discussion covers types of practitioners and researchers, analysis of research reports, and function of an interpreter for these reports.

CONCRETE CURING COMPOUNDS . . 34-31

H. S. MEISSNER and S. E. SMITH — May-June 1938, pp. 549-560 (V. 34)

Bituminous and clear curing compounds are described and the Bureau of Reclamation test proced-

ure for determining their relative efficiencies is outlined. Moisture loss and abrasion test data are given for specimens coated with clear paraffin base, asphalt cut-back, coal tar cut-back, and asphalt emulsion.

FIELD SURVEY OF MASS CONCRETE 34-32

F. R. McMILLAN — May-June 1938, pp. 561-572 (V. 34)

In this survey, Committee 108 attempts to determine to what extent the properties peculiar to mass concrete are responsible for conditions observed in massive structures. Effect of improved workmanship and changes in materials on properties of concrete are noted. These effects are demonstrated by descriptions of Crystal Springs, Elephant Butte, Arrowrock, Morris, and Boulder dams, and others unidentified.

SOME TIME-TEMPERATURE EFFECTS IN MASS CONCRETE 34-33

JOE W. KELLY — May-June 1938, pp. 573-588 (V. 34)

Effect of type of cement, placement temperature, water-cement ratio, and cement content on heat generation are evaluated. Heat dissipation is discussed. Effect of casting and curing temperatures on strength is plotted. Effect of temperature (and a few other variables) on the following properties of mass concrete is discussed: workability, water gain, permeability, elasticity, plastic flow, hygral length changes, thermal expansion, conductivity, and specific heat. Fifteen references are listed.

ON THE WORK OF THE COMMITTEE ON ARCHITECTURAL CONCRETE OF THE EXPOSED AGGREGATE TYPE AND THE THOMAS ALVA EDISON MEMORIAL TOWER 34-34

JOHN J. EARLEY — May-June 1938, pp. 589-604 (V. 34)

Recounts duties and history of the committee on Architectural Concrete of the Exposed Aggregate Type. Describes the Edison Memorial Tower and includes details of aggregate selection, necessary to secure designed color effect. Use of architectural concrete facing slabs as formwork is discussed and illustrated. Problem of aggregate size and gradation is presented and reference made to the work of Feret in this field.

SHOULD THE TYPE OF INDETERMINATE PROBLEM DETERMINE ITS METHOD OF SOLUTION? 34-35

G. A. MANEY — May-June 1938, pp. 605-624 (V. 34)

This paper is prepared to bring out by simple illustration the logic of the claim that the type of indeterminate problem determines its method of solution. It reviews the modern methods of analysis for rigid frame problems. The example of a multiple joint rigid building frame under vertical load is solved by preferred ("fixed-end moment") method. The precise slope-deflection, tabular slope-deflection, moment area, and "consistent deflections" methods are applied to several examples. The study proposes to guide the engineer to an efficient choice of analysis method, with a view toward saving time and improving design.

TESTS OF RIGID FRAME BRIDGES...34-36

WILBUR M. WILSON and RALPH W. KLUGE — May-June 1938, pp. 625-648 (V. 34)

Reports tests conducted by the University of Illinois Engineering Experiment Station in cooperation with the Portland Cement Association. Test specimens and apparatus are described and influence lines for the several loading combinations are plotted. Effect of hinged bases and horizontal restraint on moment in rigid frames are discussed. Structure was loaded to failure and crack development noted. Design recommendations are made on basis of evaluated test results.

PRINCIPLES OF CONCRETE SHELL DOME DESIGN 34-37

ERIC C. MOLKE and J. E. KALINKA — May-June 1938, pp. 649-708 (V. 34)

A review of the assumptions for the ordinary beam theory is given, and it is found that it is far from correct to treat high diaphragm (wall-like) beams as well as thin shells in general with the law of the straight line distribution of stresses. Airy's stress function method is recommended for the calculation of such structures. Dome and shell dome are defined.

It is shown that a series of simply shaped shell domes with proper stiffening members can be used to build strong, light and economical structures. Examples are cited of the construction of Z-D shell domes in America.

The theory of shell structures is presented in such a way that the reader who is not interested in mathematical details is able to picture the stress distribution over the membrane. It is found that shell cupolas supported at a few points only, show stress distribution similar to the ones observed on diaphragm beams. The calculation of shell domes is carried out with the stress function method and the stress distribution is shown by trajectories in isometric views. Twenty-six references are listed.

Proceedings V. 35

THE BOND BETWEEN CONCRETE AND STEEL 35-1

H. J. GILKEY, S. J. CHAMBERLIN, and R. W. BEAL — Sept. 1938, pp. 1-20 (V. 35)

Reviews the subject of bond between concrete and steel, summarizing work of earlier investigators and presenting new data. Includes discussion, evaluation, and documentation; intended to answer questions for the designer and to raise questions for the investigator.

CONCRETE WEARING SURFACES FOR FLOORS 35-2

COMMITTEE 804 — Sept. 1938, pp. 21-32 (V. 35)

Data and recommendations on concrete floor surfaces for hard wear, with record of new accelerated tests; suggests a specification outline for materials and workmanship both held within narrow limits. A departure from usual practice is presented for criticism.

TESTS OF REINFORCED CONCRETE COLUMNS UNDER SUSTAINED LOADING 35-3

F. E. RICHART and R. H. HEITMAN — Sept. 1938, pp. 33-40 (V. 35)

Tests of 32 columns of Series 3 of the ACI column investigation, which had been held under sustained loading for 6 years. These columns, some of which had developed steel stresses, due to plastic flow of the concrete, of more than 30,000 psi, showed the same strength as columns that had not been under load. Plain columns, unloaded for 6 years, then placed under sustained load, showed negligible plastic flow.

OVERVIBRATION AND REVIBRATION OF CONCRETE 35-4

LEWIS H. TUTHILL and HARMER E. DAVIS — Sept. 1938, pp. 41-48 (V. 35)

Effects of overvibration are rarely encountered in concrete of medium and the drier consistencies, in the wetter consistencies horizontal stratification may result with detriment to durability. Tests show that as long as the concrete has not become so stiff that revibration will not restore plasticity, revibration benefits, does not harm concrete.

RIGID FRAME BRIDGES 35-5

COMMITTEE 314 — Nov. 1938, pp. 69-72 (V. 35)

Factors involved in the design of rigid frame bridges. Existing basis for specifications.

A SHORT-TIME TEST FOR EFFECT OF TYPE OF CEMENT ON CONCRETE SHRINKAGE 35-6

G. E. TROXELL — Nov. 1938, pp. 73-80 (V. 35)

Procedure using short-time test results on 3 x 6-in. concrete cylinders and on 1½ x 1½ x 12-in. mortar bars from which the long-time shrinkage of concrete can be predicted with reasonable accuracy. Use is made of conversion factors determined for the special test conditions.

BOND CREEP AND SHRINKAGE EFFECTS IN REINFORCED CONCRETE 35-7

J. R. SHANK — Nov. 1938, pp. 81-92 (V. 35)

Bar splices were kept under constant load for more than 2 years during which time one bar of one test moved past the other 0.04 in. under a bond stress of 153 psi without losing the load. This was six times as great as the average of five other tests. Stresses in the steel of similar specimens not under load showed that practically all of the stress due to shrinkage disappeared after 25 days. Before cracking occurred the stresses were only 40 percent of those calculated from data of unreinforced shrinkage.

A PRECISE MOMENT DISTRIBUTION METHOD 35-8

JOSEPH A. WISE — Nov. 1938, pp. 93-112 (V. 35)

A single cycle method of moment distribution is presented. Precise carry-over and distribution coefficients are first calculated for the frame. In place of a carry-over factor of ½, the precise carry-over factor (which is between 0 and 5 for members with constant moment of inertia) is used, and the far end of the member is not assumed fixed. The precise distribution factor is used to distribute moments, and this factor takes into account the degree of restraint at the far end of the member. Numerous examples are given illustrating the application of the method to rigid frames and continuous beams. Curves are also given for beams with varying moment of inertia.

BEAMS WITH INTERMEDIATE EXPANSION HINGES IN RIGID-FRAME BRIDGES 35-9

D. H. PLETTA and LEONARD C. HOLLISTER — Jan. 1939, pp. 149-172 (V. 35)

Expansion hinges, developed by the California Highway Department, capable of transmitting shear but no thrust or moment, and located at about the quarter point of interior girders on long multiple-span, rigid-frame, concrete bridges are described in detail. It is claimed that they preserve structural continuity and enhance aesthetic possibilities more so than older methods of breaking girders over interior piers. As their incorporation complicates design, charts were developed for the hinged beams so that they could be treated as similar solid beams when analyzing the structure by moment distribution. The charts materially reduce design time.

MIXER EFFICIENCY OR MORTAR-MIX TESTS 35-10

O. G. PATCH — Jan. 1939, pp. 173-180 (V. 35)

A practical method of determining necessary mixing time, optimum charging methods, effect of blade wear, effect of changes in blade positions or shape, maximum allowable overloads, or results with only partial loads. The method consists of a comparative analysis of mortar samples.

TESTS OF THE POTENTIAL DURABILITY OF HORIZONTAL CONSTRUCTION JOINTS 35-11

CHAS. E. WUERPEL — Jan. 1939, pp. 181-188 (V. 35)

Presentation is made of freezing and thawing tests on 4- and 6-in. diameter concrete cores, containing horizontal construction-joint planes, removed from hydraulic structures. The results indicate, (1) that such joints are highly resistant to deterioration by frost action when carefully cleaned with air and water jets, (2) that deterioration due to frost is most likely to develop in the zone of concrete immediately below the joint plane if material water gain occurred in the concrete mixture. The tests were intended to supplement permeability and flexural strength tests on similarly prepared joints by other agencies.

CORNER EFFECTS IN RIGID FRAMES . 35-12

JOSEPH A. WISE — Jan. 1939, pp. 189-192 (V. 35)

The moments in beams at the face of columns in rigid frames is less than the moment at the intersection of the center lines of the members. Also, the zone of intersection of the members, tends to cause an increase in stiffness at the ends. The problem is discussed and a tentative method of obtaining the moment at face of column is proposed.

REINFORCED CONCRETE GIRDER BRIDGES OF OVER 100 FT SPAN . . . 35-13

K. HAJNAL-KONYI — Jan. 1939, pp. 193-200 (V. 35)

Presents a definition of girder bridges based on the bending moment diagram; classification is in six types. A number of reinforced concrete girder bridges with solid webs of over 100 ft span in 17 countries, maximum spans and years of completion, are classified according to their cross section and average width per one main girder.

MAINTENANCE AND REPAIR OF BRIDGES 35-14

CONDE B. McCULLOUGH — Feb. 1939, pp. 229-256 (V. 35)

Maintenance costs for highway bridge structures are affected by a number of factors — original design adequacy, traffic burden, local climatic conditions, and the character of the stream itself all play an important part. Those major items of maintenance expense for timber structures, steel structures, and structures of plain and reinforced concrete are discussed with emphasis on reinforced concrete in areas of low temperature and heavy ice and snow (structures in that portion of Oregon east of the Cascade Range) with many annual cycles of freezing and thawing. Specialized technique for waterproofing handrails, balustrades and other exposed structural portions, and moderate-heat cement are used. Reports average unit costs for those items of expense ordinarily encountered in the maintenance of the various types of highway bridge construction, and treats of the effect of design details on bridge maintenance expense and the development of special low-maintenance structural types.

"ORDINARY CONCRETE" 35-15

MILES N. CLAIR — Feb. 1939, pp. 257-276 (V. 35)

Author finds "ordinary concrete," most of it made by common laborers, a remarkable material in performing with "reasonable satisfaction" the functions intended. But he finds it costly, wasteful, cracked, spalled, honeycombed, leaky, nonuniform and unsightly. He tells how, by simple means, which he describes, (with modern knowledge, better specifications, and insistence that they be followed) good concrete can be had to justify, on a dollars and cents basis, the necessary additional supervision.

MIXTURES, PLACING AND CURING FOR ARCHITECTURAL CONCRETE . . . 35-16

R. S. PHILLIPS — Feb. 1939, pp. 277-284 (V. 35)

Architectural concrete differs from ordinary structural concrete in that it must be sightly, whereas structural concrete is primarily utilitarian. Its exposure to the elements makes necessary a degree of durability not required in protected structures. Specifications and methods considered satisfactory for structural concrete should be studied carefully and modified where necessary to insure sightliness and durability. Paper considers important factors: grading of aggregates, water-cement ratio and workability of the mix, methods of handling and placing and adequate curing. Recognition by architect and contractor alike of the new problems involved is essential to a successful architectural concrete structure.

LOW HEAD PERMEABILITY TESTS OF MORTAR POTS 35-17

J. C. PEARSON and R. F. ADAMS — Feb. 1939, pp. 285-288 (V. 35)

Describes percolation tests on 1:4 mortar "flower pots," indicating that thin-walled specimens of this type may be expected to show fairly wide variations. Data on 22 such pots, carefully made and cured, showed losses after 40 days under test of 4.5 to 9 ml of water per day.

THE PRESIDENT'S ADDRESS........35-18

JOHN J. EARLEY — Apr. 1939, pp. 313-316 (V. 35)

THE NAVY'S NEW SHIP MODEL TESTING PLANT 35-19

HUGO C. FISCHER — Apr. 1939, pp. 317-336 (V. 35)

Describes the procedure for the manufacture and placing of precast exposed-aggregate panels used as face forms for concrete walls of buildings. Gives reasons for adoption of a three-hinged concrete barrel arch for the roof of the main basin building and the construction procedure for placing the reinforcing and concrete of the arch including the setting of the steel for the Mesnager type hinges. Describes procedure for minimizing future movement of basin walls on account of shrinkage, changes in moisture content and live load deformations. Includes descriptions of "plastic mosaic" decorative concrete as used for interior walls.

A SYSTEM OF CONCRETE CONTROL FOR SCATTERED SMALL JOBS, AS USED BY A LARGE ORGANIZATION 35-20

R. B. YOUNG and W. SCHNARR — Apr. 1939, pp. 337-348 (V. 35)

Since 1919 the Hydro-Electric Power Commission of Ontario has been applying quality control methods to its concrete work. While the knowledge of quality control could be applied to the big jobs, the scattered small jobs presented a different problem. But by 1926 jobs as small as 1000 cu yd had been done using a modified control technique. From thereon followed rapidly the development of "instructions" for superintendents and foremen on jobs not exceeding 500 cu yd. These "instructions" have now been revised in the light of more than a decade of experience and are presented by the authors — not as an answer to, but as a contribution toward the solution of the problem of quality control on small jobs. Control methods which the commission finds adequate and workable for its scattered small jobs would have to be altered for general application but these "instructions" may, nevertheless, provide a key to the problem of "ordinary concrete."

CONCRETE AS AN ARCHITECTURAL MATERIAL 35-21

(A group of 6 papers, as listed 35-21a to 35-21f, from joint session with the New York Chapter, American Institute of Architects.)

Apr. 1939, pp. 349-384 (V. 35)

— CONCRETE FOR GENERAL ARCHITECTURAL USE 35-21a

ELY JACQUES KAHN — Apr. 1939, pp. 351-354

Why is concrete not more acceptable to the architect for general use? He is wary of prefabricated slabs for he asks why they crack, become frayed at the edges, are not waterproof, and soil easily. The concrete industry may have the answers to these questions and similar worries when concrete is considered for use in important buildings. Let the concrete men state their case and give the architect the benefit of their advice.

— CONCRETE IN ARCHITECTURAL SERVICE 35-21b

LEOPOLD ARNAUD — Apr. 1939, pp. 355-358

Unrestricted by requirements of standardization, concrete is adaptable as field-fabricated material or as shop-fabricated units. Its nonmodular qualities make it eminently suited to contemporary building methods and design. It is an active agent in the changing form of architecture. There should be a moderation of the exaggerated requirements of our building laws to reduce cost and massiveness and increase flexibility of design. The chief problem is with finishes — texture and color. What can be done to remedy the deficiency of an extra operation for aesthetic effect. Needed improvements are: good integral texture, nonfading color, capable of accurate control and good weatherability.

— REMARKS ON DURABILITY OF CONCRETE 35-21c

ROY W. CARLSON — Apr. 1939, pp. 359-364

A statement of factors affecting the durability of concrete; the fatigue action of volume changes produced by changes in temperature and moisture; the freezing of water in the pores of concrete; the phenomenon of bleeding; the thermal, elastic, and hygral properties of the constituents of concrete. Emphasis is placed on the need for test methods which will permit more accurate prediction of durability.

— COOPERATION NEEDED FOR ARCHITECTURAL CONCRETE 35-21d

A. J. BOASE — Apr. 1939, pp. 365-378

Replies to questions of Ely Jacques Kahn and Leopold Arnaud regarding alleged spalling, cracking, absorption, and impermanency of exposed concrete. Suggests remedies by closer attention to new developments and techniques, viz., "treated concrete," reinforcing steels, thin slabs, and details, and stresses need for cooperation between architects, engineers and contractors. Discusses behavior of structures induced by foundation restraints (illustrated with small scale models), colored aggregates with use of bond transfer method, discoloration, and erosion.

— CAST STONE AS AN ARCHITECTURAL MATERIAL 35-21e

C. G. WALKER — Apr. 1939, pp. 379-384

Explains causes of shortcomings mentioned by Ely Jacques Kahn and gives present status of material. Cast stone being originally given role of imitative substitute, present users are advised to recognize it as concrete, permit it to express its own character, exercise intelligent discrimination in its selection and purchase, permit sufficient time for curing and seasoning, and disregard individual manufacturers' claims for superior merits of various manufacturing processes.

— THE CHARACTERISTICS OF CONCRETE FOR ARCHITECTURAL USE 35-21f

JOHN J. EARLEY — Apr. 1939, pp. 385-392

Monolithic reinforced concrete, without a well designed and well executed surface treatment, does not even suggest the potentialities of color and texture which concrete affords. It is a mistake to think of concrete as a cheap material, or to impose on it the conventions frozen by other masonry materials. There is more difficulty in competing with the cheapest cut stone than with any better grade of material or workmanship. Concrete offers the best, economically, when the architectural requirements of form and color are most difficult. Such requirements take full advantage of the characteristics of reinforced concrete.

The full development of concrete as an architectural medium is not solely in the hands of the concrete industry. The industry must add a sense of architectural beauty, scale, form, decoration and a sense of propriety. A reinforced concrete building may be successfully placed in forms made of thin, precast reinforced concrete slabs made by trained architectural craftsmen.

DURABILITY OF PAVEMENT CONCRETE — EXPERIENCE IN PENNSYLVANIA.35-22

SAMUEL W. MARSHALL — Apr. 1939, pp. 393-404 (V. 35)

Reports data obtained from a comprehensive survey of concrete highway paving slab behavior in three adjacent Pennsylvania areas differing appreciably in

climate. Quality of concrete aggregate also varies considerably in the different areas. Observations were made from standpoints of surface condition and structural condition of the paving slab, three classes (or stages) of failure recognized. In general check surveys confirmed original findings. A marked increase in rate of concrete deterioration is noted as climatic conditions become more severe. Concrete in all three areas is subjected to an appreciable amount of freezing and thawing but in one area the weather conditions are particularly severe. In the area of severest weather the quality of concrete aggregate is lower than in the others and heaving of subgrade is more prevalent. Existence of many factors influencing concrete paving slab durability is recognized but no attempt is made to interpret results of the survey in detail. Results suggest that present conceptions of the useful life of concrete pavement may require modification for localities in which many of the factors involved may be unfavorable to the lasting qualities of concrete.

DURABILITY OF PAVEMENT CONCRETE — EXPERIENCE IN CONNECTICUT . . 35-23

E. C. WELDEN — Apr. 1939, pp. 405-416 (V. 35)

Connecticut practice in the construction of concrete pavements has seen many changes, both in design, and methods of construction. Since the early twenties coarse and fine aggregates of good quality have been readily available. The use of a gravel or stone base under the pavement, and also the minimum amount of water necessary for workability of the concrete, has had much to do with the relatively good condition of the pavement concrete. Expansion joints and fillers in many cases have proved disappointing. Experience to date indicates that the use of vibrators with mixes of the proper consistency will improve the quality and durability of pavement concrete.

APPLICATION OF THE RESULTS OF RESEARCH TO THE STRUCTURAL DESIGN OF CONCRETE PAVEMENTS . 35-24

E. F. KELLEY — June 1939, pp. 437-464 (V. 35)

Results of research, applicable to the structural design of concrete pavements, are reviewed and their significance indicated. It is shown that the stress analyses of Westergaard, with certain modifications, are suitable for use in pavement design; that warping stresses due to temperature may be as great as the stresses due to heavy wheel loads; and that when designed on a comparable basis for the combined stresses of load and temperature the thickened-edge cross section has no particular advantage over the section of uniform thickness. The paper discusses the design of steel reinforcement and of transverse and longitudinal joints.

THE BLEEDING OF PORTLAND CEMENT PASTE, MORTAR AND CONCRETE 35-25

T. C. POWERS — June 1939, pp. 465-480 (V. 35)

Bleeding is identified as the result of subsidence of temporarily suspended solids. It occurs in two stages: a period of constant rate followed by one of diminishing rate. The rate during the constant period follows a general law derived from Poisseuille's law of capillary flow. The water content of the mix and the surface area of the solids are the major controlling factors, but with these constant, different materials show individuality, due to unidentified characteristics. A simple law governing bleeding capacity (subsidence per unit original height) is developed. The ideal mix from the standpoint of bleeding is defined.

TESTS OF CONCRETE CURING MATERIALS 35-26

F. H. JACKSON and W. F. KELLERMANN — June 1939, pp. 481-500 (V. 35)

Tests were made to determine (1) the relative efficiency of a number of curing materials, and (2) to develop a standard testing procedure for use in specifications. The curing materials included, in addition to burlap, calcium chloride; sodium silicate; six waterproof papers; an asphalt emulsion; an asphalt cutback; a straw-colored lacquer-like liquid; and a rubber (latex) emulsion. Tests indicated that the effectiveness of such materials as waterproof paper and liquid curing materials applied with a spray is materially increased when preceded by a 24-hr application of wet burlap.

CONCRETE DESIGN VS. CONCRETE PLACING — THE NEED FOR COOPERATION 35-27

GEORGE L. LUCAS — June 1939, pp. 501-516 (V. 35)

Defective concrete is largely the result of lack of cooperation and coordination among designing engineers, construction engineers, specification writers, and field inspectors. Presents typical examples, such as crowded reinforcement, improper methods of placing, weak and ambiguous specifications, and incompetent inspection. Proposes as a cure for the condition a simple remedy — cooperation and coordination prior to the letting of contracts.

SOME FACTORS INFLUENCING RESULTS OF PULL-OUT BOND TESTS 35-28

CARL A. MENZEL — June 1939, pp. 517-544 (V. 35)

Data from studies made at the Research Laboratory of the Portland Cement Association, designed to show the effect of some of the many factors influencing the results of pull-out bond tests. It represents a progress report in an extensive investigation of bond resistance. Data presented cover the influence of the following factors on the loads developed in pull-out specimens; type of bar surface, length of embedment, type of lug on deformed bars, position of lug, consistency of concrete, thickness of concrete around the bar, position of the bar with respect to the placing of the concrete, leakage of water from the molds immediately after placing. Results are given for concrete of different cement contents and ages at time of test. Load-slip curves are presented based on measurements at both the loaded and the free end of the bar. Comparison is given between data from the present investigation and those obtained in earlier studies.

PAINT FOR DURABILITY OF CONCRETE SURFACES 35-29

PAUL O. BLACKMORE — June 1939, pp. 545-552 (V. 35)

1400 concrete blocks were prepared under direction of Portland Cement Association and were painted and exposed at Cincinnati, Ohio, by the Ault & Wiborg Corp. Eleven types of concrete primers and five types of finishing coats were exposed in all possible combinations with each other. Two primers were outstanding. All finish coats behaved well over these two primers.

Colors used were red oxide, toluidine red, chrome green, ultramarine blue, iron blue, chrome yellow, chromium oxide, mapico yellow, and white. Results given in tabular form and discussed.

FACTORS AFFECTING THE RESISTANCE TO FREEZING AND THAWING OF VIBRATED CONCRETE MADE OF CRUSHED DOLOMITE 35-30

M. O. WITHEY — June 1939, pp. 553-560 (V. 35)

Reports effect of 150 cycles of freezing and thawing on the flexural and compressive strength of 100 concrete prisms. Little or no damage was suffered by concrete with 0.54 water-cement ratio, by weight, containing 4¾ sacks of cement per cu yd. The flexure test was a far more sensitive measure of resistance to freezing and thawing than the compression test.

DURABILITY OF CONCRETE PAVEMENT — EXPERIENCES IN NEW YORK STATE 35-31

E. C. LAWTON — June 1939, pp. 561-580 (V. 35)

A resume of field behavior of some 440 miles of concrete pavement constructed for experimental purposes by New York State with different proportions

and combination of aggregates. Field service records of these pavements were made and compared with laboratory tests of aggregates used. The purpose was to study the durability of cement concrete pavement as affected by coarse aggregate such as stone, gravel, and slag; as affected by sands of different characteristics, such as high and low kaolin; and as affected by blended cement composed of different proportions of natural and normal portland cements. The projects studied, identified by name and listed.

Proceedings V. 36

RECONSTRUCTION OF THE ICE SKATING RINK AT THE UNIVERSITY OF ILLINOIS 36-1

JOHN DOAK — Sept. 1939, pp. 1-20 (V. 36)

Describes the reconstruction of a large ice skating rink floor. Failures first occurred in the original floor where wood wedges had been left in the concrete between the brass contraction joints and the adjacent pipes. The corrosion and pitting of the pipes adjacent to the wedges was thought to have been due to galvanic action, the moist wood forming the return path for the electrolytic current as it passed from the pipe to the brass. The calcium chloride brine released from these early leaks spread rapidly throughout the sand cushion causing rapid deterioration of the entire floor system. Comparison of construction details and failure of other major ice skating rinks revealed possibility of failure from other sources than the galvanic action created by the local battery. The new floor system was designed to eliminate, insofar as possible, all apparent causes of past rink failures. The sand cushion was eliminated and the thickness of the concrete was increased from 3¾ to 5⅝ in., monolithic, placed and finished in a continuous operation without expansion, contraction, or construction joints, eliminating the brass strips or other dissimilar metals. Uncoated steel pipe was used free from mill scale, oil, or foreign matter that would destroy bond with the concrete. The pipes were joined by oxy-acetylene welds, and supported on rolled steel T-sections cast in the concrete. The concrete was designed for maximum density and maximum shrinkage and carefully placed.

DESIGN COEFFICIENTS FOR BUILDING FRAMES 36-2

A. J. BOASE and J. T. HOWELL — Sept. 1939, pp. 21-36 (V. 36)

Presents a short, easily applied, readily understood method for analysis of building frames by principles of continuity to conform to modern code demands giving all accuracy necessary for commercial and practical requirements. Moment coefficient tables giving maximum and minimum moment coefficients for building frames of variable spans are given, with examples of their use.

EFFECT OF WEIGHT OF TAMPERS AND NUMBER OF TAMPS ON THE FLEXURAL STRENGTH OF CONCRETE SILO STAVES 36-3

C. A. HUGHES, DALTON G. MILLER, and PHILIP W. MANSON — Sept. 1939, pp. 37-48 (V. 36)

Reports tests of 502 concrete silo staves made at commercial plants. The transverse strengths were determined for 324. The chief variables were the weight of tampers and the number of tamps per stave. The number of staves per sack, the aggregate grading, and the consistency were also varied. For the materials and methods of manufacture used — (a) Increasing the weight of the tampers from 50 to 75 lb, increased the transverse strength, the increase varying both with the number of tamps and the mix. (b) The transverse strength increased with increase in number of tamps from 2 to 6 tamps. Beyond 6 tamps the effect on the transverse strength was influenced also by the mix and by the weight of the tampers. (c) In nearly all cases staves made with 2 tamps of the heavy tamper were stronger than staves made with 6 tamps of the normal one. (d) The thickness of tamped staves varies considerably. Hence if the load per inch of width is to be used as a measure of quality, it should be corrected to correspond to a specified thickness.

TESTS OF CONSIDERE HINGES UNDER DIRECT STRESS, BENDING AND SHEAR 36-4

G. C. ERNST — Sept. 1939, pp. 49-64 (V. 36)

Results from and analysis of tests of Considere hinges. Two concrete strengths were used with various combinations of rotation, thrust, and shear. Resistance to rotation was measured and three spiral percentages were included. Design formulas were developed, design procedures recommended, and design charts provided.

HIGH YIELD-POINT STEEL AS TENSION REINFORCEMENT IN BEAMS 36-5

BRUCE JOHNSTON and KENNETH C. COX — Sept. 1939, pp. 65-80 (V. 36)

Results of tests of 32 rectangular concrete beams reinforced with four different types of high yield-point steels. The beams had an effective depth of 12 in., a width of 12 in. and a distance center-to-center of supports of 9 ft. The four types of steel: (1) hard grade steel, (2) nickel steel (one beam only), (3) square twisted bars, and (4) "twin-twisted and stretched" bars. Results show that when a concrete beam is reinforced against diagonal tension failure, the strength is determined by the total yield strength of the steel (steel area times yield-point stress) and not by the type of steel.

NATURAL PERIOD OF VIBRATION OF BUILDING FRAMES 36-6

JOHN E. GOLDBERG — Sept. 1939, pp. 81-96 (V. 36)

Presents method for direct analytical determination of the natural period of vibration of building frames. It is shown that the characteristic deflection curve to which the freely vibrating structure oscillates may be determined by a process of successive converging approximations, the method of dynamic convergence. Simplified slope-deflection formulas are used in determining the shape of the curve. Knowing the shape of the curve, the period may be calculated by comparing the potential energy of the deflected structure with the kinetic energy of the system. The method is applicable to buildings, bridges, and other structures.

TESTS ON CONCRETE MASONRY UNITS USING TAMPING AND VIBRATION MOLDING METHODS... 36-7

KURT F. WENDT and PAUL M. WOODWORTH — Nov. 1939, pp. 121-164 (V. 36)

Results of a comprehensive, correlated series of tests on concrete masonry units made with seven different aggregates, cinders, Haydite, limestone, Pottsco, sand and gravel, Superock, and Waylite. Comparative data show the effect of two different types of molding, vibration, and tamping on compressive strength, absorption, capillarity, specific weight, durability, volume change, and thermal expansion coefficient for each aggregate. Similar comparative data are presented for variations in cement content for each aggregate.

THE CORRIDOR BEAM FLOOR 36-8

C. A. WILLSON — Nov. 1939, pp. 165-168 (V. 36)

Describes a shallow floor system which was used in the design of the new men's dormitories at the University of Wisconsin. A thick corridor slab was substituted for deep beams of the usual type, making it possible to reduce story heights, cut the cost of formwork, and simplify the erection of partitions.

TESTS OF THE RESISTANCE TO RAIN PENETRATION OF WALLS BUILT OF MASONRY AND CONCRETE 36-9

R. E. COPELAND and C. C. CARLSON — Nov. 1939, pp. 169-192 (V. 36)

Reported investigation of the problem of building rainproof masonry walls. Masonry wallettes, 32 in.

wide, 48 in. high and 4, 8 and 12 in. thick were exposed to a simulated wind-driven rain and the rate of moisture penetration was determined. Construction types included cast-in-place concrete and unit masonry of brick, concrete block and tile and combinations thereof. Other factors such as quality of workmanship and mortar composition were studied. Information as to effectiveness of cement paints as a water-resistant coating on concrete masonry is given. The performance of the brick walls was influenced principally by quality of workmanship. Plasticity of lime in mortar was a significant factor in the brick wall tests but mortar composition as regards ratio of cement to lime was unimportant. Results are summarized in 33 conclusions.

FORMS FOR ARCHITECTURAL CONCRETE 36-10

A. J. BOASE — Nov. 1939, pp. 193-204 (V. 36)

Contrasts practices in form construction for structural and architectural concrete. Discusses materials acceptable for contact surfaces, choice of woods or plywoods, and grades of lumber for effects desired. Describes correct practices in erection of forms, backing, bracing, nails, ties, preparation of forms, rate of placing concrete, construction joints, and provisions necessary for form removal. Numerous form details illustrated.

PRESTRESSED REINFORCED JOISTS UNDER LOADING TESTS.......... 36-11

R. E. MILLS and W. B. MILLER — Nov. 1939, pp. 205-212 (V. 36)

A series of studies at Materials Testing Laboratory, Purdue University, which evaluate several of the possibilities concerning the use of precast beams or joists for small house construction. Three typical precast joists (3 in. x 8 in. x 12 ft long) were studied as follows: A prestressed Haydite concrete joist, a conventional Haydite joist, and a prestressed segmental joist. Comparative test values were determined for both conventionally-reinforced and prestressed units and are presented in graphical form. The results include a theoretical analysis of each joist in comparison with the stress measurements in the tests.

PROPOSED REVISIONS OF "BUILDING REGULATIONS FOR REINFORCED CONCRETE" (ACI 501-36T) 36-12

COMMITTEE 501 — Jan. 1940, pp. 237-264 (V. 36)

Supersedes 32-26
Superseded by 37-5

These proposed revisions were discussed in convention and referred back to committee.— See Nov. 1940 for later report (item 37-5), adopted by 1941 convention; ratified by letter ballot July 21, 1941.

A QUESTIONNAIRE ON CONCRETE VIBRATION 36-13

ARTHUR RUETTGERS — Jan. 1940, pp. 265-272 (V. 36)

Summarizes the opinions expressed by members of Committee 609, Vibration of Concrete, in reply to a questionnaire devised by the committee chairman. The questionnaire was instrumental in developing a program for the further work of the committee, by indicating (1) what truths or generally accepted findings regarding vibration as a means of compacting concrete have emerged from previous investigation and experience, and (2) what important phases of the subject remain to be investigated to remove them from the field of speculation and controversy.

CONCRETE AGGREGATE DEVELOPMENT ON THE CLAYTOR HYDRO PROJECT . 36-14

G. W. HUTCHINSON — Jan. 1940, pp. 273-296 (V. 36)

Describes in summary the development of both fine and coarse aggregate for concrete on the Claytor Hydro Project, near Radford, Va. Improvement in particle shape and gradation enhanced the value of the aggregate when compared with the product usually secured from primary crusher operation. Departure from somewhat orthodox procedure was made by the use of relatively large amounts of the dolomitic aggregate passing a No. 100 sieve. The general procedure allowed appreciable savings.

PRECAST JOIST CONCRETE FLOOR SYSTEMS 36-15

COMMITTEE 711 — Jan. 1940, pp. 297-312 (V. 36)

A critical examination of precast concrete joist and superimposed concrete floor systems and construction methods as practiced in United States to report the state of the art along with recommendations believed sufficiently conservative for general use. It brings together salient facts showing that a correctly designed concrete beam can be satisfactorily made in a machine or in a factory and how the beam so manufactured can be made to develop T-beam action in connection with a floor slab, and to record design and manufacturing procedure likely to produce satisfactory results.

PROPOSED RECOMMENDED PRACTICE FOR MEASURING, MIXING, AND PLACING CONCRETE 36-16

COMMITTEE 614 — Feb. 1940, pp. 329-352 (V. 36)

Superseded by 30-6

An outline of best practice for measuring, mixing, and placing concrete. In some respects somewhat in advance of some common practice, but in the interest of progress and improvement. The refinements recommended are intended to promote uniformity and to eliminate segregation in aggregates and concrete. With better assurance of uniformity, more efficient concretes having either greater durability or economy are practicable.

READY-MIXED CONCRETE OPERATIONS IN PHILADELPHIA 36-17

ALEXANDER FOSTER, JR., HERBERT J. KNOPEL, and HERBERT J. WHITTEN — Feb. 1940, pp. 353-372 (V. 36)

Traces history of ready-mixed concrete in Philadelphia, describing in some detail the economic considerations which have influenced its successful development. The market for this material is explained, followed by a discussion of various problems faced by the ready-mixed concrete producer. A description of the organization and the plants is given. Methods of technical control receive considerable attention. The concluding paragraphs outline several interesting studies conducted in the interest of improvement of the quality of ready-mixed concrete.

THE DESIGN OF CONCRETE MIXES . . 36-18

CHARLES T. KENNEDY — Feb. 1940, pp. 373-400 (V. 36)

Presents a method for the design of the concrete mix with respect to workability. A "workability" factor is developed which has a similar relation to the workability of the concrete as the water-cement ratio has to the strength. The author finds that for any given cement and water-cement ratio, this factor depends on the relative quantities of cement, water, and aggregates and on certain easily determined physical characteristics of the aggregates. Instead of the original data on which the method is based, its validity is demonstrated by application to an independent series of tests. Examples are given of the application of the method to problems of design and to the selection of the proper aggregate, and attention is called to certain implications with respect to economy and quality.

PROPOSED SPECIFICATIONS AND METHODS OF TESTING FOR CONCRETE STAVES TO BE USED IN FARM SILO CONSTRUCTION 36-19

COMMITTEE 714 — Feb. 1940, pp. 401-408 (V. 36)

The content of the report is indicated by the title. It was presented as information and for discussion only.

PRESIDENT'S ADDRESS 36-20

F. E. RICHART — Apr. 1940, pp. 425-432 V. 36)

THE PROPERTIES OF CONCRETE MIXES 36-21

R. F. BLANKS, E. N. VIDAL, W. H. PRICE, and F. M. RUSSELL — Apr. 1940, pp. 433-476 (V. 36)

An attempt to assemble in exemplified form the known properties, factors, and relationships pertaining to concrete in the plastic state. Details of concrete proportioning procedure are not included, and reference is made to the properties of hardened concrete only when its requirements directly affect or predetermine certain properties of the fresh concrete. The introduction includes a brief discussion of the concrete proportioning problem and a highly condensed account of the more important historical developments. The second section discusses the known properties of concrete mixes and related facts, and presents supporting data and information from the literature and from unpublished records.

FROST RESISTANT CONCRETE......36-22

R. B. YOUNG — Apr. 1940, pp. 477-492 (V. 36)

Most frost deterioration is due to a few preventable causes, of which the most common is segregation from undersanded and harsh mixes, improper placing, and overworking. Other causes are defective construction joints, and inadequate provision for drainage. Severity of exposure is an important factor in determining the amount of frost deterioration. Frost resistant concrete is one made according to well recognized standards of quality in which, by adequate and competent supervision, more than average care has been taken with regard to those details that experience has shown to be the cause of frost deterioration.

TOLERANCES IN BUILDING CONSTRUCTION 36-23

JOHN R. NICHOLS — Apr. 1940, pp. 493-496 (V. 36)

Tolerances are proposed tentatively, allowable variation from the exactly plumb, straight, level, and true, for lines, levels, and dimensions of reinforced concrete buildings and it is suggested that eventually, after discussion, a set of some such tolerances be adopted as standard by the American Concrete Institute.

THE CONTRIBUTION OF READY-MIXED CONCRETE TO THE BUILDING INDUSTRY 36-24

H. F. THOMSON — Apr. 1940, pp. 497-508 (V. 36)

The development of commercial service in delivering ready-mixed concrete in urban centers has represented one of the significant advances in building practice during the last 15 years. The industry has pioneered in introducing more accurate control methods; these refinements now enable small jobs to secure as reliable control of the concrete used as is available on large jobs. The advances in quality of ready-mixed concrete have influenced improvements in the production of all other concrete used in a community. Ready-mixed concrete offers to the building trade a service which has proven helpful in convenience, speed, ability to handle winter work, and in other respects. The way toward further improvements in concreting practices has been pointed out by this infant in the building field.

RESUME OF REPORT BY COMMITTEE 317 (REINFORCED CONCRETE DESIGN HANDBOOK) 36-25

A. J. BOASE — Apr. 1940, pp. 509-512 (V. 36)

Reference is made here to a special, separate ACI publication, whose content is only briefly indicated as follows (a 132-page book): "One of the important objectives of the committee has been to prepare tables covering as large a range of unit stresses as may be met in general practice.

"A second and equally important aim has been to reduce the design of members under combined bending and axial load to the same simple form as is used in the solution of common flexural problems."

ATTEMPTS TO MEASURE THE CRACKING TENDENCY OF CONCRETE 36-26

ROY W. CARLSON — June 1940, pp. 533-540 (V. 36)

A method is described for determining the resistance to cracking of concrete subjected to drying. A column of concrete is restrained by a centrally-located bar of steel, which is threaded near its ends to provide good bond there while it is coated over its mid-length portion to prevent bond. When the concrete dries and shrinks enough to become stressed beyond its tensile strength under the test conditions, an easily visible crack occurs. A few preliminary test results are offered, which in some cases at least, seem to be more nearly in line with field observations than are the results of free-shrinkage tests.

STRESS INCREASES IN COMPRESSIVE STEEL UNDER CONSTANT LOAD CAUSED BY SHRINKAGE 36-27

G. A. MANEY and M. B. LAGAARD — June 1940, pp. 541-552 (V. 36)

Data from various sources, which have formed the basis of their conclusions that continued deformations in compressive steel of reinforced concrete members under constant loads are caused by shrinkage and not by "plastic flow" or "creep." This applies to the common case in practice where the compressive steel receives its load only through the bond in the concrete and not by direct application at the ends. They do not contend that "flow" of concrete does not occur under high loads, but present the opinion that a "flow" in bond occurs as well as a flow in compression, thereby causing no additional stress in the reinforcement. They explain the additional deformation in a concrete column beyond that normally attributed to shrinkage, by an increase in load intensity due to reduction of the effective compression area from warping. This is caused by more rapid drying in the outside elements of the column. They present evidence to explain the high time-deformations on the compressive surface of plain concrete beams under sustained load, on the basis of eccentric shrinkage rather than flow. What is usually called flow or "creep" in a drying out column under sustained load is identified by them as shrinkage since changes of comparable magnitude are not found to occur in wet loaded columns. An attempt is made to reallocate the responsibility for time changes under load, between shrinkage and flow.

PERMEABILITY, ACID, AND ABSORPTION TESTS OF MORTARS USED IN DRY TAMPED SILO STAVES.36-28

C. A. HUGHES — June 1940, pp. 553-580 (V. 36)

Data on the permeability, acid resistance, and absorptions of specimens cut from concrete silo staves of widely varying properties. A method of test for relative acid resistance was developed using 0.16N lactic and acetic acid solution. Data from companion tests using phosphoric acid solutions, molasses solutions, corn juice, and silage juice indicate that the lactic and acetic acid solution may be used to determine qualitatively the relative resistance of mortars to the above solutions. Quantitatively the relative resistance depends both on the solution and the condition of exposure. For these tests, the resistance of mortars to corrosion increased with increase in the flexural strength and with increase in the cement content but no "critical" strength or cement content was apparent. The absorption tests showed clearly that the 24 hr absorption was inferior to the 5 min absorption, or the ratio of 5 min absorption to the 24 hr absorption, as a criterion of mortar quality. A few data on hydrostatic heads in silos indicate the need for more information on the exposure conditions existing in a silo.

EFFECT OF IMPACT ON REINFORCED CONCRETE BEAMS 36-29

T. D. MYLREA — June 1940, pp. 581-596 (V. 36)

The impact resistance of reinforcing steels of various grades was investigated by tests on 10 x 16 in. beams on a span of 8 ft, reinforced with varying

amounts of steels of different grades. These tests indicate the great value of even small amounts of reinforcement in beams subjected to impact, the enormous reserve against collapse after the yield point of the reinforcement has been passed, and the fact that, within the limits of the tests, when subjected to energy loads even more severe than are likely to be met with in practice no noticeable difference in strength was shown by beams reinforced with different grades of steel.

REVISED APPLICATION OF FINENESS MODULUS IN CONCRETE PROPORTIONING 36-30

HENRY L. KENNEDY — June 1940, pp. 597-616 (V. 36)

Presents a method of concrete proportioning in which trial mixes are used only for the final adjustment of mix parts. Fineness modulus is used only as a measure of effective fineness of combined aggregate to facilitate testing and control. Actual tests for compressive strength or other properties are used as a reliable check of the mix. Preference is given to the use of water-cement ratio as the first step in the design. When the fineness of combined aggregate is expressed in terms of fineness modulus instead of as gravel-sand ratio, a single determination of optimum fineness serves for all reasonable gradations of fine or coarse aggregates of a given type and maximum size. Optimum fineness is determined from compression tests on a series of concretes of fixed cement content and substantially equal workability. The concrete in this series which gives maximum strength seems to define the coarsest and most economical mix from which fully satisfactory concrete can be made. Charts are provided for use only in selecting fineness modulus where the making of compression tests is not feasible prior to selection of proportions.

COMPARISON OF THE PHYSICAL AND MECHANICAL PROPERTIES OF HAND RODDED AND VIBRATED CONCRETE MADE WITH DIFFERENT CEMENTS..36-31

GEORGE W. WASHA — June 1940, pp. 617-648 (V. 36)

Presents results of a comprehensive series of tests on vibrated and hand-rodded concrete. The variables for each method of placement are five different mixes and five different cements. Particular attention has been paid to the lean mixes, the leanest vibrated mix being 1:6:12 by weight, with only 2.2 sacks of cement per cu yd of concrete. The results obtained indicate the effects of the variables on compressive strength, permeability, specific weight, absorption, linear changes due to alternate heating and water soaking, modulus of elasticity, Poisson's ratio, shrinkage, and plastic flow.

THE APPLICATION OF SOME OF THE NEWER CONCEPTS TO THE DESIGN OF CONCRETE MIXES 36-32

W. M. DUNAGAN — June 1940, pp. 649-684 (V. 36)

Present day concrete proportioning practice can be benefited by (1) an "up to date," simple and reasonably accurate method for approximating mixes before work starts so that required materials may be estimated and so that a guide is furnished for the first "trial mix," and (2) a computation method to facilitate mix adjustment in the interest of workability, during the progress of the work. Good specifications are based on such a procedure. Two factors have hindered the full provision of these two details: First, no system has provided a direct approximation of the water necessary for workability, second, the rules governing the balance between fine and coarse aggregate have not been clear; these have been assumed as discoverable only by trial. Author has developed by test and condensed into diagrams a means for approximating the first item (the water requirement of a mix) and has used a formula developed by C. A. G. Weymouth to provide a clue for a discovery of the second (the fine-coarse balance). He uses these data in conjunction with procedures taken from other authors to develop a complete system for proportioning concrete mixes.

Author states his system for proportioning mixes in an eight point outline citing precedent for the use of the main principles. In the body of the paper he develops the use of individual items and submits data to show the accuracy which may be expected. The paper concludes with an appendix in which typical problems are solved.

Proceedings V. 37

PLAIN AND REINFORCED CONCRETE ARCHES 37-1

COMMITTEE 312 — Sept. 1940, pp. 1-28 (V. 37)

A summary of the work done by Committee 312 since the publication of its progress report in 1932, and presents for discussion a suggested specification for reinforced concrete arch design. Further investigation has been made of the effects of shrinkage and plastic flow. Measurements on large arches at Pittsburgh over a period of years are presented and discussed along with the results of other investigations. Recommendations are made as to the calculations of moments and thrusts due to loading and volume changes. A new method is proposed for the design of the arch rib based on ultimate strength formulas and a new approach to the question of factor of safety for members subjected to direct load and flexure.

TUNNEL LINING METHODS FOR CONCRETE COMPARED 37-2

LEWIS H. TUTHILL — Sept. 1940, pp. 29-48 (V. 37)

The comparative merits of various methods for lining tunnels with concrete are frequently in question. The question includes consideration of equipment as well as methods. The purpose of this paper is to answer these questions in the light of current experience.

The subjects of leakage, shrinkage, cracking, and contraction joints are treated because they are inseparably involved in the results of placing methods.

CRACKS IN EXTERIOR MASONRY BEARING WALLS OCCURRING WHERE CONCRETE ROOF AND FLOOR SLABS BEAR ON THE WALLS 37-3

A. M. KORSMO and B. M. THORUD — Sept. 1940, 1940, pp. 49-56 (V. 37)

Reports cracks which have developed in new buildings in which typical construction is of solid reinforced concrete floor and roof slabs supported on exterior masonry walls and interior beams and columns. In general, the cracks occur in horizontal joints of the external wall surfaces at corners of the buildings under concrete floor and roof slabs. The description of the phenomena is offered as a step toward solution of a general problem.

THE BOND STRENGTH OF RUSTED DEFORMED BARS 37-4

BRUCE JOHNSTON and KENNETH C. COX — Sept. 1940, pp. 57-72 (V. 37)

Results of about 420 bond pull-out tests on deformed bar specimens of 78 different sizes or degrees of rust are reported — three different series. In the first, bars were selected from a stockpile and were classified as to degree of rust. Although these bars were of the same nominal size and type it was found that small differences in the size of lug produced a greater difference in test results than the degree of rust. In the second series, deformed bars of different sizes cut from identical stock were stored both in a moist room and out of doors in an exposed position. The time of exposure was a variable and the maximum time for the out-of-door exposed specimens was 15 months. The third series of tests consisted of bars exposed out of doors as a check test on the results of the second series.

PROPOSED BUILDING REGULATIONS FOR REINFORCED CONCRETE 37-5

COMMITTEE 318 (formerly 501) — Nov. 1940, pp. 77-140 (V. 37)

Supersedes 36-12
Superseded by ACI 318-41

This report (a complete text rather than a list of revisions of the 1936 tentative Regulations, 501-36T)

was adopted by the 37th annual convention February, 1941, and ratified by letter ballot of Institute members canvassed July 21, 1941.

CONCRETE PERFORMANCE IN AN ARID CLIMATE 37-6

THOMAS E. STANTON — Nov. 1940, pp. 141-156 (V. 37)

Describes studies conducted in the Imperial Valley, Imperial County, Calif., on the performance of portland cement concrete in an arid region where the average humidity and rainfall are low and temperatures in the summer high. A test section of pavement constructed in May, 1929, was in service and under observation for 11 years. Several different curing methods were used, including bituminous impervious membranes and impervious paper of different types as well as sodium silicate, and earth and water cure. In addition to the curing tests, determination was made of the effect of admixtures of volcanic ash (pozzolanic type), diatomaceous earth, hydrated lime and calcium chloride as well as of a seven sack mix, the standard being six sacks of cement. In general, regardless of the method of cure or the admixtures the performance of all of the test sections has been satisfactory, except for certain construction defects which cannot be attributed to any special method of curing or admixtures. The test section was exceptionally smooth after 11 years service, the roughness as measured by the roughometer being only 24.2 in. per mile.

CORRELATION BETWEEN RAPID IMMERSION AND STANDARD FOUR CYCLE PER DAY FREEZING AND THAWING TESTS 37-7

E. R. DAWLEY — Nov. 1940, pp. 157-160 (V. 37)

Progress report of an investigation attempting to shorten the time required to measure resistance of rock to freezing and thawing. The rapid method consists of a direct immersion of the specimen in freezing solutions for 10 min, then thawing, in running water for 5 min, wiping, and returning to the freezing solution. Two solutions, Skellysolve F and mercury, were used. Tests of three kinds of rock by the standard method and the rapid method are described. Disintegration of the specimens was slightly more rapid using the rapid method. The standard method caused more damage by splitting.

THE EFFECT OF VARIOUS REAGENTS ON THE HEAT LIBERATION CHARACTERISTICS OF PORTLAND CEMENT 37-8

L. R. FORBRICH — Nov. 1940, pp. 161-184 (V. 37)

The temperature rise of concrete caused by the hydration of the cement and the resulting tendency to crack due to subsequent cooling, have long been recognized. In this paper a method is described of controlling the heat evolution of cements by the addition of small quantities of active reagents. Data are presented showing the effects of a dispersing agent, an inorganic accelerator, an organic catalyst, and various combinations of these reagents, on the heat liberation characteristics of several cements. Data also are presented showing the effects on strength, durability, and shrinkage of concrete, of three combinations of the reagents which appeared to have practical value. One of these combinations was designed specifically for concrete in which heat evolution, particularly at the early ages, is important, and the other two were designed for use in ordinary concrete.

FIRE DAMAGE TO GENERAL MILLS BUILDING AND ITS REPAIR 37-9

J. FRUCHTBAUM — Jan. 1941, pp. 201-252 (V. 37)

Repair of the General Mills building at Buffalo, N. Y. after the fire of February 15, 1940, presented many unusual problems — replacing large areas enclosed on all sides by portions of the building remaining intact. This problem was further complicated due to the number of floors involved. Literature on repairs of a fire damaged job is lacking in specific detail. The effect of heat on the strength of concrete and steel has received little attention and the available information was insufficient to permit a determination of what should or should not be replaced in border line cases. The engineer in charge of this work conducted the necessary tests even to cutting and measuring carrying capacity of columns involved.

A complete program, based on these data was evolved. Unusual details were designed and detailed for all the complicated cases that a flat slab presents. The repairs were made on schedule. Careful records were kept of the progress and costs. Check tests of loading and deflections on repaired panels were made. All of this information is presented in this paper.

PROBLEMS PRESENTED BY THE LAKE WASHINGTON FLOATING BRIDGE. .37-10

CHARLES E. ANDREW — Jan. 1941, pp. 253-268 (V. 37)

The largest pontoon bridge in the world and the first to be built of reinforced concrete presented numerous problems of design and construction, those resulting from the use of concrete being of course original. Some of these are presented.

Why a pontoon bridge was selected; why it was built of reinforced concrete; the essential features of the design; how the concrete was made watertight; what results were achieved in this respect; how the contractors built the 25 pontoon sections; how they were assembled, interconnected, anchored; what provision is made for the passage of large ships; what are the bridge's notable features in service — all of these questions and topics are the material with which this paper deals.

A TWELVE-YEAR RECORD OF CONCRETE MIXTURES 37-11

V. L. GLOVER — Jan. 1941, pp. 269-280 (V. 37)

Volumetric proportioning of aggregates for concrete was discontinued by the Illinois Division of Highways at the beginning of the 1930 construction season and the mortar-voids method of design adopted in its place; aggregates were proportioned by weight and a system worked out of controlling the mixtures in the field. Accurate records of proportioning and results obtained during ensuing decade are compared with records of volumetric proportioning of pavement concrete during 1928 and 1929.

After a period of development (1930 and 1931) of the mortar-voids method it was considered by 1932 entirely practical for use in large programs of construction. The marked improvement of the quality of the concrete during this period is reflected by an increase in flexural strength of about 35 percent between 1929 and 1932, as shown by the average 14-day moduli of rupture of pavement concrete — far more than can be accounted for by any increase in the quality of the cements and is believed to have been accomplished without the use of additional cement. The high standards of 1932 have been maintained.

WEATHERING RESISTANCE OF CONCRETES CONTAINING FLY ASH CEMENTS 37-12

RAYMOND E. DAVIS, HARMER E. DAVIS, and JOE W. KELLY — Jan. 1941, pp. 281-296 (V. 37)

Investigation, extending scope of investigation previously reported, was undertaken to determine whether fly ashes of moderately high carbon content could be used advantageously as pozzolanic replacements for small percentages of portland cement, particularly with regard to weathering resistance of concrete. Eleven fly ashes varying in carbon content (1 to 17 percent) and fineness (specific surface 2500 to 5500 sq c per g) were each admixed with a modified portland cement, with 10 and 20 percent of cement replaced by an equal weight of fly ash. The fly-ash cements thus produced were tested to determine the water requirement, time of setting, autoclave expansion, tensile strength of standard mortar, compressive strength of concrete, drying shrinkage of concrete, and resistance of saturated concrete to the action of repeated freezing and thawing. Herein the performance of the fly-ash cements is compared with that of the portland cement, and the influence of

carbon content, fineness, and amount of fly ash is shown. On the whole, the use of fly ash resulted in concretes of quality equal or superior to that obtained with the portland cement alone.

FLAT PLATE RIGID FRAME DESIGN OF LOW COST HOUSING PROJECTS IN NEWARK AND ATLANTIC CITY, N. J. 37-13

JOSEPH DI STASIO — Feb. 1941, pp. 309-324 (V. 37)

Six low-cost housing developments in Newark and one in Atlantic City are described. Economies in cost and speed of erection were effected by the use of a novel type flat plate rigid frame design. Typical details are shown, and a summary discussion given of the basis of design, construction methods, and comparative costs.

TUNNEL LINING PRACTICE ON THE DELAWARE AQUEDUCT 37-14

CHARLES M. CLARK and GEORGE SPANN — Feb. 1941, pp. 325-348 (V. 37)

The Delaware aqueduct is a deep rock pressure tunnel, 85 miles long, to carry water from upstate reservoirs to New York City. Throughout its length, the aqueduct will be lined with concrete to provide a waterway of circular cross section 13½, 15, or 19½ ft in diameter. The construction was performed under 12 contracts held by 11 contractors. Although great variations exist in the methods and equipment employed under the several contracts, results that are satisfactory both as to progress and quality of finished work were obtained in each case.

Gives a general description of the work, the requirements for cement and aggregates for concrete, and describes the methods used in batching, transporting, mixing, and placing concrete for the lining. Reference is also made to the special construction required for portions of the tunnel through badly broken or faulted and decayed rock and to the rapid sustained progress made in placing the lining under several of the contracts.

EXPEDITING CONSTRUCTION ON THE PENNSYLVANIA TURNPIKE 37-15

H. HERSHEY MILLER — Feb. 1941, pp. 349-360 (V. 37)

Engineers of Turnpike Commission were confronted with the task of placing more than 4 million sq yd of 9-in. uniform reinforced concrete pavement in 2½ months.

The 12 ft pavement consisted of four lanes, each lane 160 miles long. The analysis of the problem and the steps taken to solve it are the subject matter of this paper.

CONCRETE CONTROL ON THE PENNSYLVANIA TURNPIKE 37-16

I. L. TYLER — Feb. 1941, pp. 361-376 (V. 37)

Deals with problems encountered in controlling quality of paving concrete on a large project, the Pennsylvania Turnpike, constructed in record time. Procedures adopted for maintaining such control are briefly discussed. Suggesting that uncontrolled mixing water has been the important factor in most of the recorded failures of concrete structures, the paper directs particular attention to the phase of construction having to do with its control. Data are presented which indicate that the actual amount of mixing water in concrete may be considerably greater than is generally supposed. Effects of type of concrete placing equipment on quality of concrete and some effects of construction practices and procedures are considered. Suggestions are offered which may be of value in preparing paving specifications.

PROPOSED SPECIFICATIONS FOR CONCRETE PAVEMENTS AND BASES 37-17

COMMITTEE 617 — Feb. 1941, pp. 377-412 (V. 37)

Superseded by 40-7.

Seven of the eight members of Committee 617 approved the report as here submitted to the Institute (one member not participating in committee's work). The Standards Committee released it for publication for a period of general study and discussion but not at once for formal presentation to the Institute on motion for adoption as an ACI standard.

DESIGN AND CONTROL OF CONCRETE PAVING MIXTURES — TEXAS 37-18

E. B. CAPE — Feb. 1941, pp. 413-432 (V. 37)

Presents a method employed by the Texas Highway Department for concrete paving mix proportioning and control based on absolute volume. Two types of specifications are described: the modified water-cement ratio specifications (arbitrary cement factor), and the strength or quality specification which places no limit either on minimum cement factor or maximum water-cement ratio. The proportioning and control employed with each of these specifications are explained and examples given. Eight-year records of the service behavior of numerous low cement factor pavements are presented as evidence that concrete pavement of proper quality is obtained when the concrete is proportioned by the absolute volume method under strength and quality specification. This specification and proportioning methods permit materials to be used with the greatest efficiency and therefore assure concrete of the desired quality at the lowest cost.

LONG-TIME OVERLOAD TESTS OF A T-BEAM FLOOR PANEL 37-19

L. E. GRINTER and BURGE KEPFORD — Feb. 1941, pp. 433-440 (V. 37)

A simple T-Beam floor panel designed for light live loading was tested under the action of concentrated loads and under the uniform ACI Code loading. The panel was then overloaded for 6 months by the application of double the ACI Code loading. Finally, after time for recovery, the original test loadings were replaced and their actions are compared with the original strains and deflections. The ability of the slab to carry 3.7 times the design loading and then to act elastically under normal loads is established.

CONCRETE EXPOSED TO SULFUR WATER 37-20

JOHN S. NELLES — Feb. 1941, pp. 441-452 (V. 37)

Progress report on The Detroit Edison Co. tests showing the condition of concrete specimens comprising different mixes, admixtures, and cements, after 12 years exposure completely submerged in flowing sulfur water. The data include compressive strength curves and extent of disintegration, from which some conclusions have been drawn and some recommendations made.

UNUSUAL CONCRETE ROOF OF HOLLOW GIRDERS AND PRECAST SLABS 37-21

HOMER M. HADLEY — Feb. 1941, pp. 453-460 (V. 37)

A concrete roof was designed to be wholly precast and of minimum weight. The contractor preferred to cast the thin-sectioned hollow girders in place. His simple and effective methods of placement of the girders' 1½-in. top and bottom slabs and for the 2-in. side and cross-webs produced thoroughly satisfactory results.

THE IDA B. WELLS LOW-COST HOUSING PROJECT IN CHICAGO . . 37-22

CARL A. METZ — Feb. 1941, pp. 461-472 (V. 37)

Records principal elements of design and construction of a low-cost housing group of 125 buildings of fireproof construction in Chicago — 1662 dwelling units, 6901 rooms — at a cost per room of $990. Reinforced concrete frame construction was used rather than masonry bearing walls and the reasons are given. Floors are clay tile filler and concrete joists with clay tile soffits and 2 in. concrete top slab.

DESIGN OF CHICAGO'S INITIAL SYSTEM OF SUBWAYS 37-23

P. F. GIRARD — Feb. 1941, pp. 473-496 (V. 37)

The Chicago subway design work was started October 1938, and at the end of 1940 the tunnel work was 85 percent and the station work 35 percent complete. The entire project is essentially one of tunnel construction. Conditions at the start of the project and the design work that was accomplished since that time are described. First a general description of the work and brief review of some of the essential structures. The remainder of the paper describes the structural design of the work, with special emphasis on the concrete design of the different tunnel sections.

CONSTRUCTION OF CHICAGO'S INITIAL SYSTEM OF SUBWAYS 37-24

V. E. GUNLOCK — Feb. 1941, pp. 497-508 (V. 37)

The construction of subways in Chicago by tunneling methods has been a moot question for many years. Proof that this can be accomplished now exists. These subways have been constructed by tunneling methods through Chicago's underlying stratum of soft blue clay. The paper describes the two methods used in the subway tunnel construction, mentions some of the special problems encountered, describes methods of placing the concrete, and explains the control exercised to insure sound concrete in the finished structure.

DESIGN OF LIGHTWEIGHT ZONOLITE CONCRETE MIXES 37-25

GREGORY P. TSCHEBOTARIOFF — Feb. 1941, pp. 509-516 (V. 37)

The results of a relatively limited number of tests with lightweight Zonolite concrete mixes are given to illustrate peculiarities of such mixes which necessitate a special approach to the problem of their design. The investigation did not cover all of the factors which are likely to affect the properties of such lightweight concretes, but some of these are listed and briefly discussed.

THE AMERICAN CONCRETE INSTITUTE — HOW IT FUNCTIONS — WHAT IT STANDS FOR (Presidential Address)..37-26

R. B. YOUNG — Apr. 1941, pp. 529-536 (V. 37)

CONSISTENT INCONSISTENCIES IN THE CONSISTENCY OF CONCRETE 37-27

C. H. SCHOLER — Apr. 1941, pp. 537-548 (V. 37)

Concrete segregation, usually considered objectionable, is to some extent necessary and desirable, as in placing and finishing operations at surfaces and around reinforcing. Concrete should be designed accordingly. "Bleeding" of concrete, long recognized as objectionable, has its uses. Construction practice depends on free water for lubrication. Arbitrary reduction of bleeding may lead to serious errors. Density of concrete is a common measure of its quality. Concrete technicians know that the densest concrete is not obtained with rich mixtures, yet density is commonly considered a result of rich mixtures. The use of cement admixtures to promote workability actually reduces density by incorporating air, but nevertheless improves durability.

CRACKING IN CONCRETE DUE TO EXPANSIVE REACTION BETWEEN AGGREGATE AND HIGH-ALKALI CEMENT AS EVIDENCED IN PARKER DAM 37-28

H. S. MEISSNER — Apr. 1941, pp. 549-568 (V. 37)

Excessive expansion has been recognized for some time as causing that type of concrete distress manifested by a characteristic random-pattern cracking. Recent disclosures point to an additional new explanation in the chemical reaction between high-alkali cement and the mineral constituents of certain aggregates. It is possible that many failures, which have been incorrectly interpreted, may ultimately be clarified when analyzed for this suspected action.

Paper describes a chain of circumstantial evidence which connects one case of deteriorating concrete with this type of action. The cement used was known to have contained large amounts of soda and potash. After considerable research it was discovered that the natural sand and gravel contained small amounts of andesite and rhyolite, which were reacting in the concrete with such cement. Part of the evidence was a gel substance, a by-product of the reaction, identified as sodium silicate.

COLUMNS WITH HIGH YIELD POINT REINFORCEMENT DESIGNED UNDER THE ACI CODE 37-29

THOR GERMUNDSSON — Apr. 1941, pp. 569-576 (V. 37)

The customary type of reinforced concrete column is not too satisfactory for large loads. An improvement is proposed by means of which columns may be made smaller and more economical. At the same time, their size may be kept the same throughout a tall building, 20 in. being considered the optimum size for all columns carrying up to 1,000,000 lb. This results in standardization of design, detailing and erection of floor construction on various levels. To accomplish that it is proposed to use eight bars in each column, the maximum size of bars being 2 in. round and their yield point stress 75,000 psi.

THE DESIGN AND CONTROL OF PAVING CONCRETE IN IOWA 37-30

BERT MYERS — Apr. 1941, pp. 577-588 (V. 37)

Reports Iowa Highway Commission practices over 20 years, in the design and control of paving concrete: (1) The design of proportions to make the most economical use of the aggregates available, particularly mixtures containing a high ratio of mortar to coarse aggregate, (2) the introduction of the practice of weighing aggregates for paving concrete, (3) improvements in methods for the control of thickness of pavement slab, (4) design of equipment for accurate control of measurement of mixing water, (5) detailed methods for control of proportions.

TECHNICAL TEDIUM OR OTHERWISE 37-31

R. W. CRUM — Apr. 1941, pp. 589-596 (V. 37)

Although this "brief dissertation on the art of presenting technical papers" (author's subtitle) loses in dramatic effect as a published record, it has fun mixed with solid substance. In response to an appropriate question Mr. Crum presented this paper at the "Quiz"— that novel (for ACI) and final session of the Institute's 37th Annual Convention in Washington February 18-20, 1941. With the author's hitherto little known histrionic talent the presentation was a "scream"— for all this contribution's serious intent. If you are going to present a paper (and who isn't?) read it.

THE USE OF CARBON DIOXIDE TO REDUCE EFFLORESCENCE ON ASBESTOS-CEMENT SHINGLES 37-32

CLYDE R. HUTCHCROFT and HARVEY R. ANDERSON — Apr. 1941, pp. 597-604 (V. 37)

Describes experimental work with carbon dioxide gas to reduce efflorescence on asbestos-cement shingles. Factors investigated in connection with the reaction of carbon dioxide gas with the free lime of the shingles were: The effect of different arrangements of shingles for exposure to the carbon dioxide; the effect of the age and density of the shingles, concentrations of carbon dioxide gas, effect of temperature, moisture content, and of the depth to which the reactions occurred.

STUCCO MECHANICALLY POLISHED ON COLUMBIA BROADCASTING STUDIOS 37-33

WALTER B. KASPAREIT — Apr. 1941, pp. 605-612 (V. 37)

In modernizing the street facade of the Columbia Broadcasting Studios, New York City, face brick was cut back and three-coat stucco applied, the finishing coat being carborundum-ground to a smooth finish. This facing avoided removing the entire front of the building; saved time and cost. The materials and methods are described with suggestions for their improvement on other similar jobs.

THE USE OF ABSORPTIVE WALL BOARDS FOR CONCRETE FORMS...37-34

W. R. JOHNSON — June 1941, pp. 621-632 (V. 37)

Summary of laboratory tests and field observations at Kentucky Dam on use of highly absorptive wall boards for concrete form linings. The use of absorptive wall boards is large scale application of principles practiced by John J. Earley in his use of absorptive plaster molds for architectural concrete. Absorbent forms eliminate voids and air pockets on concrete surfaces but this is of secondary value when compared to the greatly increased quality of the surface produced — highly resistant to abrasion, freezing and thawing, and possessing other desirable qualities of good concrete. Sticking of form liner to concrete surface is the greatest obstacle to overcome.

CONSTRUCTION OF THE TERMINAL BUILDING — WASHINGTON NATIONAL AIRPORT 37-35

W. E. REYNOLDS — June 1941, pp. 633-640, (V. 37)

Records briefly the nature of the project and the practice in formwork — materials and assembly, the concrete mix, placing and finishing methods employed in obtaining satisfactory results in the construction of The Terminal Building, Washington National Airport.

THE GROUTING OF CONCRETE STRUCTURES 37-36

T. C. CREAGHAN — June 1941, pp. 641-648 (V. 37)

Describes repair work done on downstream side of certain hydraulic structures in Canada; covers instances of stoppage of water flow back of frost line, and repair of structure in the dry. The temporary repair of surfaces to permit grouting of interior under high pressures, and a brief description of the grout specification for different types of jobs.

DISCREPANCIES BETWEEN THE VOLUME OF FRESH CONCRETE AT THE READY-MIX PLANT AND THE VOLUME IN FINAL PLACEMENT....37-37

HERBERT J. KNOPEL — June 1941, pp. 649-656 (V. 37)

Rapid growth of the ready-mixed concrete industry has entailed production and service problems. These include technical problems of precision control. Absolute volume method for deducing resulting yield of wet mixes is sound. Wet mass is altered by evaporation losses, by densification due to agitation, and by bleeding through forms or subgrades, these varying with degree of manipulation. Purpose of this paper is to show where these losses may occur.

PLACING AND FINISHING PAVEMENT CONCRETE 37-38

H. F. CLEMMER — June 1941, pp. 657-664 (V. 37)

Discusses possibilities of increased speed and performance in concrete highway construction through use of larger equipment but emphasizes coordination of machinery for increased output in all operations. Increased output of a paver can be utilized only with comparable increases in performance with placing and finishing equipment.

INVESTIGATION OF CAUSES OF DELAYED EXPANSION OF CONCRETE IN BUCK HYDROELECTRIC PLANT...37-39

H. A. KAMMER and R. W. CARLSON — June 1941, pp. 665-672 (V. 37)

The concrete in Buck Hydroelectric Plant, built in 1912, gave first noticeable evidence of expansion in 1922. Expansion continued until at date of this writing dimensions had increased by about ½ percent, and potential growth remained. No serious expansion was observed in another hydroelectric plant built only 3 miles away at same time with the same cement, but with different coarse aggregate. The Buck coarse aggregate was crushed phyllite (near slate) and the other crushed gneiss. Comparable expansion was observed in certain accelerated laboratory tests on concretes made with the Buck aggregate but with modern cements. The laboratory specimens expanded only where a high-alkali cement was used or where alkali was added to a cement. Also, up to the age of 1 year, specimens expanded only when stored at an accelerating temperature (110 F in these tests).

It is concluded that expansion is due to a reaction between aggregate and alkalis in cement, probably to form sodium or potassium silicate, and that test specimens stored at 70 F will expand in due time.

EVIDENCE IN WASHINGTON OF DETERIORATION OF CONCRETE THROUGH REACTION BETWEEN AGGREGATES AND HIGH-ALKALI CEMENTS 37-40

BAILEY TREMPER — June 1941, pp. 673-688 (V. 37)

Deterioration of concrete in two areas in Washington described. Unsatisfactory results are connected definitely with combinations of certain aggregates and cements. The aggregates when used with other cements and the cements when used with other aggregates have produced concrete of satisfactory durability. Evidence indicates that, with these aggregates, the cements that were used in durable concrete were low in alkali and those used in concrete which has deteriorated were high in alkali. Investigations have not been completed, however, and there is some evidence of a negative nature.

THE NATURE OF THE PROCESSES LEADING TO THE DISINTEGRATION OF CONCRETE, WITH SPECIAL REFERENCE TO EXCESS ALKALIS....37-41

CHARLES P. BERKEY — June 1941, pp. 689-692 (V. 37)

Paper was presented to conference group at Bureau of Reclamation, Denver, as of possible assistance, through viewpoint of a petrologist, in an approach to problems presented by chemical activity of some rocks in the presence of high-alkali cement. It is not to be read as an explanation of disturbing phenomena recently observed in concrete structures, but, as author says, "a suggestion based on petrologic analogy."

Proceedings V. 38

THE INFLUENCE OF VIBRATION, CONSISTENCY AND GRADING OF AGGREGATE UPON THE DESIGN OF CONCRETE 38-1

G. W. HUTCHINSON — Sept. 1941, pp. 9-28 (V. 38)

Data supplement those previously published: "Concrete Aggregate Development on the Claytor Hydro Project" (ACI Journal January 1940). They are from the results of several investigations in the Claytor laboratory of factors affecting the design of concrete which could not be fully reconciled with existing theory. The more important indications:

1.—That an optimum gradation exists for each aggregate or set of aggregates, when of given maximum size and combined with a given paste content, which provides maximum workability in concrete. Gradations of aggregate either finer or coarser than the

optimum require additional mixing water to maintain equal workability.

2.—To maintain a given consistency of concrete, a greater water content per unit volume of concrete is required as the paste content is increased.

3.—The compressive strength and durability of concrete especially in the mixtures sufficiently dry to require placement by vibration, are affected by the consistency of the concrete in a manner not definitely related to the water cement ratio except when the cement content is constant.

A CONCRETE FAILURE ATTRIBUTED TO AGGREGATE OF LOW THERMAL COEFFICIENT 38-2

J. C. PEARSON — Sept. 1941, pp. 29-36 (V. 38)

Gives the highlights of an investigation to account for a rapid failure of some cast stone steps in the winter of 1937-38. Preliminary studies of the cement, aggregate and concrete gave no clue to the trouble except to show that the aggregate in some way caused rapid failure of the concrete in freezing and thawing tests. Eventually the aggregate was found to have an unusually low thermal coefficient, although resistant to frost action in itself. A number of other low coefficient aggregates were found, and in concrete subjected to freezing and thawing tests, all produced the same type of rapid failure. Such aggregates evidently produced high internal stresses at low temperatures and made the concrete particularly vulnerable to frost action.

BOND STRESS IN CONCRETE PULL-OUT SPECIMENS 38-3

DAVID WATSTEIN — Sept. 1941, pp. 37-52 (V. 38)

The purpose of this investigation was to determine the distribution of bond stress in pull-out specimens. Thirty-six 6 x 18-in. cylindrical concrete pull-out specimens containing ¾ in. diameter round bars were tested. There were four types of deformed bars and two types of plain bars (hot and cold rolled). The bond stress at the loaded end of all bars except the cold rolled bar, varied approximately linearly with the applied load. The bond stress at the loaded end of the deformed bars was considerably greater than that at the free end.

TEMPERATURE EFFECTS NEAR CONCRETE SURFACES AS AFFECTED BY HEAT LIBERATION OF CEMENT. . 38-4

LOUIS R. FORBRICH — Sept. 1941, pp. 53-64 (V. 38)

This paper attempts to show by computation temperature changes and temperature distributions near formed surfaces of some typical concrete structures before and after removal of forms. The computations showed that near the surfaces temperature rises of 25 to 45 F may be expected in 1½ to 6 ft concrete sections. Removal of forms as early as possible before the maximum temperatures occur, or if this is not practical, removal of forms as late as possible, is indicated as a means of reducing the danger of cracking due to thermal effects. The use of an additive material for reducing early heat liberation of the cement may be effective in reducing temperature rise and cracking tendency of concrete.

TESTS OF REINFORCED CONCRETE BEAMS WITH RECOMMENDATIONS FOR ATTAINING BALANCED DESIGN 38-5

KENNETH C. COX — Sept. 1941, pp. 65-80 (V. 38)

On the basis of test results from 110 rectangular beams of 4 concrete strengths and 23 percentages of reinforcement, recommendations are offered for attaining a balanced design. These are similar to Whitney's recommendations and embody a simplifying modification of the technique outlined by Whitney. These results include limited data on doubly-reinforced beams and beams of variable effective depth.

RECOMMENDED PRACTICE FOR MEASURING, MIXING AND PLACING CONCRETE (ACI 614-42) 38-6

COMMITTEE 614 — Nov. 1941, pp. 93-120 (V. 38)

Supersedes 36-16
Superseded by ACI 614-59

The nature of the report is implicit in the title. It was adopted by the 1942 convention and was ratified later by letter ballot as an Institute Standard (ACI 614-42).

A VACUUM METHOD OF MEASURING THE AIR CONTENT OF FRESH CONCRETE 38-7

GEORGE L. PIGMAN — Nov. 1941, pp. 121-132 (V. 38)

A method of measuring the air content of freshly mixed concrete has been developed, in which the air is removed at the reduced absolute pressure of approximately 17 mm of mercury. Determination of the air content is made entirely by volume measurements and does not require any information on the specific gravity of the components of the concrete.

The reproducibility of results was satisfactory and varied with the wetness of the mix, being better for the wetter concretes with a flow of 85 to 110 than for concrete with a flow of 55. The air content was increased by use of a finer sand, but was reduced by increasing the cement content of the mix.

It was found that concretes normally containing less than 1 percent of air had the air contents increased to values ranging from 1.5 to 14 percent by the addition of 0.05 percent of various aerating agents.

A STUDY OF THE CAUSE OF NONUNIFORMITY IN THE COMPRESSIVE STRENGTH OF CONCRETE PAVEMENT CORES 38-8

V. L. GLOVER — Nov. 1941, pp. 133-148 (V. 38)

It is common knowledge that the individual compressive strengths of cores from concrete pavements are less uniform than those of cylindrical test specimens made in the laboratory. This more pronounced nonuniformity is believed to be due to variables encountered in field practices which are not present in the laboratory. The Illinois Division of Highways had occasion to test a large number of pavement cores and the nonuniformity found in the test results was such as to make these results wholly unsatisfactory for the desired comparisons. A study was made to determine the causes.

An attempt was made to duplicate the nonuniformity known to exist in field concrete, proceeding on the theory that segregation might influence nonuniformity. Results indicate that the position of the coarse aggregate particles in the specimen does not affect greatly the uniformity of the compressive strength; that the amount of coarse aggregate particles in the specimen, that is, the degree to which separation of the aggregate particles and the mortar has taken place, does have an effect; that segregation of the coarser particles of aggregate from the finer ones also has an effect; and that part of the nonuniformity of compressive strength is due to the difference in age of the specimens at the time of test, pavement cores usually being tested at ages considerably greater than the usual standardized age of laboratory specimens.

DESIGN DIAGRAMS FOR SQUARE CONCRETE COLUMNS ECCENTRICALLY LOADED IN TWO DIRECTIONS 38-9

PAUL ANDERSEN — Nov. 1941, pp. 149-164 (V. 38)

Building frames of reinforced concrete are continuous space structures. In the case of beam and slab construction the vertical and lateral loads are carried to square columns through a grid system of girders. Shears and bending moments are thus transmitted to the columns (generally square) in two perpendicular planes and can be resolved into single forces eccentrically placed in two directions with respect to the column axes.

In this paper 15 diagrams are presented which will give directly, for square columns with symmetrical reinforcement and eccentrically loaded, the maximum compressive stress on the concrete as well as the maximum tensile stress in the reinforcement without first determining the position of the neutral axis. These diagrams can be used for sections reinforced with 4, 8, 12, or 16 bars.

SOME EXPERIENCE WITH PRESTRESSED STEEL IN SMALL CONCRETE UNITS . . 38-10

R. E. DILL — Nov. 1941, pp. 165-168 (V. 38)

Preventing early bond by using greased or oiled round steel rods and slowly stressing these rods against the body of the concrete, the writer built some 1400 posts and several hundred building slabs. With steel in tension and concrete in compression, neither posts nor slabs cracked and showed no weathering. A laboratory test shows how a beam so built acts when loaded to failure and the curves show how high strength steel may be used to save steel or to produce higher strength beams without increasing size or weight.

CONCRETE SPECIFICATIONS AND WATER CONTENT OF CONCRETE . . 38-11

F. I. WARBERG — Nov. 1941, pp. 169-172 (V. 38)

A plea for specifying definite credits, accruing to the owner for every failure of his contractor to meet specification requirements, heavy enough to make noncompliance unprofitable; a plea to owners that a competent, honest inspector is well worth his hire, and suggesting a test for water content of concrete after it has set. A testing laboratory should not be a subcontractor.

RECOMMENDED PRACTICE FOR USE OF METAL SUPPORTS FOR REINFORCEMENT 38-12

COMMITTEE 319 (formerly 507) — Nov. 1941, pp. 173-176 (V. 38)

Rescinded

A brief statement of practice approved by 1942 Convention and adopted as a Standard, subsequently ratified by letter ballot (ACI 319-42).

MACHINE METHODS FOR TRIMMING SUBGRADE AND PLACING CONCRETE CANAL LINING 38-13

O. G. BODEN — Nov. 1941, pp. 177-180 (V. 38)

The Bureau of Reclamation applied special machine methods to trimming subgrade and placing concrete lining on the Contra Costa Canal of the Central Valley Project. The subgrade trimming machine and the machine which placed, formed, and vibrated the concrete, spanned the canal and rode on accurately placed rails. The results are satisfactory in maintaining accurate alignment and grade.

PROPOSED RECOMMENDED PRACTICE FOR THE DESIGN OF CONCRETE MIXES 38-14

COMMITTEE 613 — Jan. 1942, pp. 193-208 (V. 38)

Superseded by 40-6

The scope of the report is indicated in the title. It was released by the Standards Committee for discussion as a basis for a further report of the committee.

CALIFORNIA EXPERIENCE WITH THE EXPANSION OF CONCRETE THROUGH REACTION BETWEEN CEMENT AND AGGREGATE 38-15

THOMAS E. STANTON, O. J. PORTER, L. C. MEDER, and ALLEN NICOL — Jan. 1942, pp. 209-236 (V. 38)

This group of papers brings up to date the work done by the Materials and Research Department of the California Division of Highways during the last 3 years in the investigation of the cause of the serious deterioration of concrete in certain areas of the State.

Many data are presented supporting the contention that the cause of the trouble is a chemical reaction between alkali in the cement and some mineral in the aggregate. Long-time (up to 3 year) test results are included and methods and results of various accelerated test procedures are described.

Studies on the subject of permissible alkali content, effect of pozzolanic admixtures, the nature of the reactive aggregates, possible correctives and the need for a comparative petrographic study of various known and unknown reactive aggregates are discussed at length.

Interesting data are presented showing the extent to which a highly reactive mineral is apparently innocuous when present in excess quantities which may be as low as only 10 or 15 percent of the aggregate particles.

Eight lines of investigation are suggested for future research.

OBSERVATIONS ON THE DURABILITY OF DRY TAMPED SILO STAVES 38-16

C. A. HUGHES and KENNETH A. ANDERSON — Jan. 1942, pp. 237-252 (V. 38)

From data obtained by subjecting cubes cut from dry-tamped silo staves to durability cycles consisting of frost action alone or a combination of frost and acid action, it is concluded that the transverse strength and absorption are not adequate criteria of the durability of dry-tamped silo staves. From a discussion of exposure conditions and evidence obtained from field inspection, it is concluded that frost action is the chief factor in silo durability though acid action is still important because of its accelerating effect on the rate of disintegration in freezing and thawing tests. The procedure for a durability acceptance test is proposed.

ABSORPTIVE FORM LINING 38-17

E. N. VIDAL and R. F. BLANKS — Jan. 1942, pp. 253-268 (V. 38)

Presents a summary of the development of the wallboard type of absorptive form lining as a practical means of eliminating defects and effecting other improvements in formed concrete surfaces. Describes briefly the laboratory investigations made, field tests to determine the practicability of the method, purchase specifications, and the experiences to date in using absorptive form lining in actual construction.

TRANSIT MIXERS USED EFFECTIVELY ON THE CONTRA COSTA CANAL . . 38-18

O. G. BODEN — Jan. 1942, pp. 269-272 (V. 38)

This, the second of three brief papers each describing some element of construction operations on the Contra Costa Canal, considers the effective use of transit mixers on a 9-mile section of the concrete lining. Five 4.34 cu yd capacity mixers delivered concrete to a canal lining machine which placed, vibrated and formed it in position — described in the first of these contributions.

SAVING STEEL IN REINFORCED CONCRETE DESIGN 38-19

R. L. BERTIN — Feb. 1942, pp. 281-288 (V. 38)

Proposes the prompt modification of the Institute's Building Regulations for Reinforced Concrete (ACI 318-41) in furtherance and support of a proposed National Emergency Code for the conservation of steel and other strategic materials, chiefly for defense construction where time is urgent and steel short; that working stresses be liberalized, live loads reduced, plain concrete encouraged and the most modern methods of design applied.

ARCHITECTURAL CONCRETE ON THE NEW NAVAL MEDICAL CENTER 38-20

HUGO C. FISCHER — Feb. 1942, pp. 289-312 (V. 38)

Describes certain features of the design, production, and setting of the precast reinforced concrete, exposed-aggregate panels used for the exterior facing of the new Naval Medical Center at Bethesda, Md.

PROPOSED SPECIFICATION FOR CAST STONE 38-21

COMMITTEE 704 — Feb. 1942, pp. 313-316.

Superseded by 41-28

A proposed new standard intended by the Committee, if and when adopted by ACI, to supersede the specification tentatively adopted in 1929 (P3-A-29T). The new specification would increase the compressive strength requirement from 5000 to 6500 psi and reduce permissible absorption from 7 to 6 percent. Has since been adopted as ACI Standard 704-44.

GOOD PRACTICE IN CONCRETE MASONRY WALL CONSTRUCTION . .38-22

KENNETH C. TIPPY — Feb. 1942, pp. 317-328 (V. 38)

Discusses some of the less understood but important details of concrete masonry wall construction details which represent the difference between ordinary and good construction — strong, durable, and watertight; the need for preshrinkage of moisture-laden masonry units before laying in a wall; the use of the proper mortar; adequate footings and foundations; use of proper lintels and sills; partitions tied to exterior walls; expansion and contraction joint; precautions with parapet and flashings and with drains and waterproofing practice.

THE EFFECT OF BELT TRANSPORTATION ON CONCRETE AGGREGATE GRADING 38-23

GORDON L. WILLIAMS — Feb. 1942, pp. 329-332 (V. 38)

Steps in the solution of the problem presented by breakage of graded concrete aggregate through 26 "flights" of a 9½-mile belt conveyor which took aggregate from the gravel plant at Redding, Calif., to the mixing plant for Shasta Dam.

THE EFFECT OF CHANGE IN MOISTURE-CONTENT ON THE CREEP OF CONCRETE UNDER A SUSTAINED LOAD 38-24

GERALD PICKETT — Feb. 1942, p. 333-356 (V. 38)

The amount and rate of plastic flow in concrete under load has been found to depend on the rate of drying. This paper shows by mathematical analysis that this is a natural consequence of nonuniform shrinkage and a nonlinear stress-creep relationship. It further shows that shrinkage cannot account for additional creep unless inelastic strain not proportional to stress is produced. Results from experiments designed to test the applicability of the theory to concrete are reported.

PRESIDENT'S ADDRESS 38-25

BEN MOREELL — Apr. 1942, pp. 421-424 (V. 38)

This brief war-inspired address was delivered by telephone and loud speaker to the convention by Rear Admiral Moreell a few weeks "after Pearl Harbor."

EARLY CONCRETE VOLUME CHANGES AND THEIR CONTROL 38-26

M. A. SWAYZE — Apr. 1942, pp. 425-440 (V. 38)

The types of volume changes occurring in concrete, in order of their incidence in a freshly mixed batch, are caused by water absorption, sedimentation, cement hydration, thermal change, and wetting or drying of the concrete.

Cement hydration causes relatively large amounts of water to be absorbed by concrete in the first 24 hr. Where curing water is not supplied during the period when concrete is heating up from cement hydration; tests with Carlson strain meters have shown the possibility of offsetting thermal expansion by the autogenous shrinkage. At the time when the concrete reaches maximum temperature, the delayed curing leaves it in an unsaturated condition.

If water is supplied to concrete during the cooling period, the induced volume change from absorption decreases shrinkage from heat loss.

This treatment will materially decrease the large thermal shrinkages which produce cracking in concrete whose final structure is established at high temperatures. It is applicable to highway slabs and structural members of similar size, but will be less effective in large masses.

An appendix presents some of the significance of the paper for the highway engineer. It deals with the harmful effects on highway surfaces of too liberal application of curing water through curing mats at early ages.

PROGRESS IN THE LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE 38-27

F. R. McMILLAN — Apr. 1942, pp. 441-448 (V. 38)

The incentives for the "Long-Time Study of Cement Performance in Concrete," announced by the Portland Cement Association in the News Letter, ACI Journal, January 1941, are found in a paragraph from that announcement as follows:

"It is of concern alike to the producer and consumer of portland cement that the performance of concrete under the rigors of service cannot always be predicted or relied upon with certainty. These predictions are based upon premises which depend upon an attempted correlation of laboratory research and observation of field operations with field performance. Since the non-reliability of the predictions seems to be due to a lack of proper correlation between laboratory and field observations and field performance, the Portland Cement Association is about to undertake a long-time study of the performance of cement in concrete."

CANAL LINING CURED BY SPRAYED COATS OF WHITE-PIGMENTED COMPOUND 38-28

O. G. BODEN — Apr. 1942, pp. 449-452 (V. 38)

The expense and inconvenience of water curing by sprinkling 24 hr a day on a project where concrete canal lining was progressing as much as 1000 linear ft per day were avoided by using sprayed curing compounds. An 8½-mile section of canal was coated with a clear compound plus burlap shading for 3 days. On the next section tests showed that a white-pigmented compound eliminated the need of burlap shading. Heat reflecting characteristics of the white-pigmented compound kept concrete temperatures as low as when the clear coated concrete was shaded.

EARTHQUAKE STRESSES IN FRAME STRUCTURES 38-29

ROBERT E. GLOVER — Apr. 1942, pp. 453-472 (V. 38)

A way of using the instrumental records obtained from past quakes to evaluate the earthquake resistant qualities of proposed or existing structures is developed. The effect of damping may be included and a method of using a torsion pendulum to obtain certain important results is described. The condition under which an earthquake allowance in the form of a transverse load proportional to the weight may be safely used is identified.

THE NATURE OF PORTLAND CEMENT PAINTS AND PROPOSED RECOMMENDED PRACTICE FOR THEIR APPLICATION TO CONCRETE SURFACES 38-30

COMMITTEE 616 — June 1942, pp. 485-504 (V. 38)

The committee presents a detailed discussion of the characteristics and uses of paints whose base, and principal ingredient, is portland cement — the factors of composition and of technique in application for satisfactory service. The report is the foundation for a report to be presented later with a view to Institute adoption as a Standard Recommended Practice.

THE PROPERTIES OF LIGHTWEIGHT STRUCTURAL CONCRETE MADE WITH WAYLITE AGGREGATE 38-31

GEORGE W. WASHA and KURT F. WENDT — June 1942, pp. 505-520 (V. 38)

Mix proportioning methods and procedures for securing fluid workable concrete without bleeding have been developed. Strength, absorption, specific weight,

toughness, stiffness, and durability characteristics of structural Waylite concrete are presented. Damage due to freezing and thawing was predicted from the change in the dynamic modulus of elasticity with excellent results. Reinforced concrete beams made with Waylite aggregate closely followed the behavior observed for sand-and-gravel concrete beams.

Proceedings V. 39

METHODS OF HANDLING AND PLACING CONCRETE AT SHASTA DAM 39-1

C. S. RIPPON — Sept. 1942, pp. 1-8 (V. 39)

Describes briefly equipment and methods employed by contractors in handling and placing 6,500,000 cu yd of concrete in construction of Shasta Dam and power plant.

EFFECT OF GRINDING IN THE LARGE MIXERS ON AGGREGATE GRADING AT HIWASSEE DAM 39-2

W. R. WAUGH — Sept. 1942, pp. 9-20 (V. 39)

Preliminary investigations revealed that changes in grading due to grinding in the mixers would be a major consideration in the concrete control. Crushing tests gave the first indication of the instability of "graywacke" and laboratory mixing tests were made to determine the relative grinding characteristics of "graywacke" and dolomite.

Preliminary tests served only to confirm the existence of the problem, and field investigations were begun concurrently with concrete placing to determine amount and character of grinding taking place in the large field mixers. "Grab" samples were analyzed periodically as a basis for adjusting "ingoing" grading to compensate for changes in grading due to grinding to get a desired aggregate grading in the mixed concrete. Later full batches were analyzed as an additional check on changes in grading due to grinding. "Split batch" charging of the "face" concrete was adopted after job trials indicated that the amount of grinding could be reduced by withholding coarse rock and cobbles from the mixers until one half the mixing time had elapsed.

Variable grinding during mixing made production of concrete of uniform quality more difficult. Several conclusions in regard to grinding are given at the end of the paper.

DEVELOPMENTS IN METHODS OF TESTING AND SPECIFYING COARSE AGGREGATES 39-3

LEWIS H. TUTHILL — Sept. 1942, pp. 21-32 (V. 39)

In suggesting a different basis for testing the screening of coarse aggregate, emphasis and restriction are placed on that portion of the undersize material which is most detrimental to the production of uniform, high quality concrete. Clean separation on a production basis is impracticable; some material slightly smaller or slightly larger than the designated nominal size range of coarse aggregate size fraction can be allowed without perceptible ill effect on the concrete. Characteristics of the undersize and common practice in the screening and handling of aggregates are discussed. A test for determination of only the "significant" (objectionable) portion of the nominal undersize is submitted, and a specification based on this test.

THE DESIGN OF BOX CULVERTS. . . . 39-4

C. R. BURKY — Sept. 1942, pp. 33-52 (V. 39)

In the Canal Engineering Section of the Bureau of Reclamation rectangular concrete box culverts are designed for a number of purposes. Box culverts are usually built to carry drainage water under canals, to carry drainage water under roads or railroads, or to carry canal water under roads, railroads, other canals, or natural drainage channels. In the work carried on by the Canal Engineering Section the most frequent use of box culverts is for the purpose of carrying drainage water under canals.

Some of the methods used in the design of box culverts are given herein, and while this is written from the standpoint of the design of box culverts, much of the procedure outlined would apply to any box structure.

WELDING OF 2-INCH SQUARE REINFORCING BARS FOR PIERS OF PIT RIVER BRIDGE 39-5

ROBERT SAILER — Sept. 1942, pp. 53-60 (V. 39)

Two-in. square reinforcing bars, 60 ft long, were used for the main reinforcement in the tall concrete piers of the Pit River Bridge. Since more than 8000 splices, laps or welds, were required laboratory tests were made to determine whether adjoining bars could be satisfactorily welded.

Results of these tests, prior to construction, showed that satisfactory welds could be obtained if low-carbon steel was used and if certain precautions were taken in the welding operations. The specifications for the steel and the necessary precautions are discussed. Tests of welds during construction confirmed the results of the laboratory tests.

"NATIONAL EMERGENCY SPECIFICATIONS FOR THE DESIGN OF REINFORCED CONCRETE BUILDINGS" TO CONSERVE STEEL 39-6

Nov. 1942, pp. 85-92 (V. 39)

To conserve reinforcing steel, as a war measure, Emergency Specifications issued by WPB, are the substance of Directive 9 which gives them force for all government war time reinforced concrete building construction. Here the new Emergency Code provisions are shown by comparison with ACI 318-41. (with Code errata)

PROPOSED RECOMMENDED STRESSES FOR UNREINFORCED CONCRETE 39-7

COMMITTEE 322 — Nov. 1942, pp. 93-96 (V. 39)

Shortage of steel for reinforcement was the immediate incentive for this report which is intended to guide the designer in the use of unreinforced concrete for suitable applications. It discusses the quality of concrete, volume changes, and recommends allowable stresses as a basis for discussion and — with due cautions — for immediate use in conjunction with Building Regulations for Reinforced Concrete (ACI 318-41).

INSPECTION OF CONCRETE FLOOR FINISH CONSTRUCTION. 39-8

A. J. BOASE — Nov. 1942, pp. 97-104 (V. 39)

The ACI Manual of Concrete Inspection has little discussion of floor finishes and refers to several other sources of information. The references are excellent so far as they go. Paper points out some of the more common defects in finishes and gives additional details of procedures which help to prevent the occurrence of such defects.

INFLUENCE OF SANDS, CEMENTS, AND MANIPULATION UPON THE RESISTANCE OF CONCRETE TO FREEZING AND THAWING 39-9

W. C. HANSEN — Nov. 1942, pp. 105-124 (V. 39)

This investigation was undertaken to determine the extent to which the resistance of concrete to frost action is influenced by the following variables: (1) different cements when used with the same sand; (2) different sands when used with the same cement; (3) excessive manipulation.

Four sands, four cements, and one coarse aggregate were used in making concretes of four different consistencies. Strengths, absorptions, and resistance to freezing and thawing were determined on all specimens.

The study showed that the influence of both sand and cement on the resistance of concrete to freezing and thawing is determined by their influence on the amount of mixing water required to give the desired consistency and their effect on the bleeding characteristics of the concrete. It was further brought out that manipulation of the surface will not have a

marked influence on the resistance if the water-cement ratio in the surface mortar is not increased thereby. A good relationship was shown between the 48-hr absorption of specimens dried 14 days in air and the resistance of the concrete to frost action.

THE DESIGN AND CONSTRUCTION OF THE CONCRETE MULTIPLE ARCH BRIDGE OVER THE SPILLWAY OF GRAND COULEE DAM 39-10

E. R. DEXTER — Jan. 1943, pp. 149-164 (V. 39)

Gives a general description of the design and construction of this reinforced concrete multiple arch highway bridge over the spillway of Grand Coulee Dam on the Columbia Basin Project, Wash.

SOME FACTORS INFLUENCING THE STRENGTH OF CONCRETE CONTAINING ADMIXTURES OF POWDERED ALUMINUM 39-11

CARL A. MENZEL — Jan. 1943, pp. 165-184 (V. 39)

Discusses the effects of small additions of aluminum powder on the strength of several types of concrete and concrete specimens. These effects result primarily from the generation of minute bubbles of hydrogen gas within the paste. This gas tends to expand the volume of the paste and increase the pressure within the mass which may be partially restrained by the confining parts of the mold. This tendency to expand the volume of the paste improves the intimacy of contact with adjacent aggregate particles and with embedded steel reinforcing bars. Under ordinary conditions the compressive strength of plastic concrete is sharply reduced with increase in porosity of the paste that occurs with unrestrained expansion. Under special conditions, particularly where the expansion is restrained, the strength may be increased by the admixture of aluminum powder. In a special case of grouted gravel concrete, marked increases in compressive strength were obtained when the expansion of the grout was restrained by the interlocked pieces of gravel and the homogeneity of the mass for this type of concrete was greatly improved. With lean mixes, or with mixes deficient in fine aggregate particles, slight improvements in strength were obtained with 6 x 12-in cylinder specimens but these were small compared to the strengths obtainable with properly designed workable mixes of the same cement content but without aluminum powder.

SAFE LOADS FOR EXISTING CONCRETE BRIDGES 39-12

F. W. PANHORST — Jan. 1943, pp. 185-192 (V. 39)

Committee 320, Safe Loads for Existing Concrete Bridges, was organized (with the author of this paper as chairman) to formulate a procedure for determining the safe loads on existing concrete bridges. The assignment is not an easy one. This paper discusses the committee's understanding of the assignment and offers a tentative procedure. The problem is complex; it is more difficult to obtain a definite answer than many realize who have been concerned only with design practice. It is impractical to assign definite values to a great number of the unknown and variable factors involved and recommendations must be based on experience, judgment, and perhaps opinion, to a large extent. The prime purpose of the paper is to elicit discussion, to assist the Committee in making its final recommendations.

THE MICROSCOPIC STRUCTURE OF HYDRATED PORTLAND CEMENT 39-13

L. T. BROWNMILLER — Jan. 1943, pp. 193-212 (V. 39)

Microphotographs illustrate the structure of neat hydrated portland cements as seen in reflected light. They show that a considerable amount of unhydrated cement remains in Type I and Type II cements after hydration for 28 days. Type III cements show much smaller percentages of unhydrated material even at earlier ages.

Most of the principal constituents of the original clinker can be recognized in the unhydrated fractions. The photographs give no evidence that any major constituent of the cement is selectively or completely hydrated at any age. The rate of hydration depends more specifically on the surface exposed to the action of the water than on the chemical constitution.

The effects of laitance formation are shown by illustrations of the difference in particle size distribution in the laitance as compared to that within the main body of the cement.

Other photographs show the size, amount, and distribution of the $Ca(OH)_2$ which is liberated during the hydration processes. It is estimated that about 15 percent of $Ca(OH)_2$ has formed at 28 days in the cements examined. The polishing and etching technique described could be applied readily for the preparation of specimens for accurate measurement of the $Ca(OH)_2$ by mechanical devices such as a Wentworth micrometer.

The final photographs show some detail of the structure of the hydrates other than the $Ca(OH)_2$. That structure is extremely complicated, but a further development of microscopic technique should be useful in solving some of the riddles which confront cement technicians in attempting to evaluate cements on the basis of performance in concrete.

SOME LONG-TIME TESTS OF CONCRETE 39-14

M. O. WITHEY and K. F. WENDT — Feb. 1943, pp. 221-240 (V. 39)

Reports results of strength and expansion tests on three series of concrete specimens begun in 1910, in 1923, and in 1937. More than 2500 concrete cylinders and a still larger number of mortar briquets and cylinders were made for these test programs. Most of the specimens were cured outdoors; some were cured under water, and others in the laboratory. Variables in types of cement, types of coarse aggregate, consistency, and methods of placement are included in these experiments.

BOMB-RESISTANT AIR RAID SHELTERS 39-15

HAROLD E. WESSMAN — Feb. 1943, pp. 241-252 (V. 39)

Outlines the problems involved in the structural design of two types of bomb-resistant shelters and emphasizes the inadvisability of any large program of shelter construction in the United States.

A shelter to resist the direct hit of a 1000-lb heavy case bomb uses a roof slab 11 ft 3 in. thick, sidewalls 6 ft thick above ground and 9 ft thick below, and a base 5 ft thick.

A surface shelter to resist blast and splinters, from a 1000-lb bomb exploding 25 ft away, employs 15-in. sidewalls and an 8-in. roof.

The author closes with a plea and a suggestion for better outside walls for future buildings.

TESTS OF COMPOSITE TIMBER-CONCRETE BEAMS 39-16

F. E. RICHART and C. B. WILLIAMS, JR. — Feb. 1943, pp. 253-276 (V. 39)

Composite beams and slabs of timber and concrete offer a useful form of construction for heavy floors of highway bridges, piers and similar structures. The essential feature of such floors is a shear connection between the timber and concrete elements. Tests on a number of types of shear units are described in this paper, and their relative effectiveness is discussed. Working stresses are proposed and methods of applying composite construction to continuous structures are briefly outlined.

BALANCED DESIGN FOR REINFORCED CONCRETE 39-17

A. J. BOASE and C. E. MORGAN — Feb. 1943, pp. 277-296 (V. 39)

The question of factor of safety on reinforced concrete design is now foremost in engineers' minds. This has been brought about by shortage of reinforcing steel and the issuance of directives increasing the permissible steel stresses. In this paper the authors question the practice of a uniform factor of safety on dead and live load and suggest a method of design which they believe would permit a better distribution of reinforcing steel than could be obtained

by a flat increase in working stresses, and at the same time reduce the required amount of reinforcing steel without a reduction in the factor of safety.

A SEMI-CIRCULAR ARCHED CONDUIT WITH UNIFORM SYMMETRICAL LOADING 39-18

STANLEY U. BENSCOTER — Feb. 1943, pp. 297-308 (V. 39)

The conduit is first considered to be divided into two parts, the base slab and the arched frame. The fixed-end moments, fixed-end shears, and stiffness value for the arched frame are presented by formulas and graphs. From these values and similar well-known values for the base slab we may determine the final moments in the conduit by a single distribution of moments at one corner by the usual method of Moment Distribution. A "shear correction factor" is given to change the fixed-end shear of the frame to the final shear. The formulas and graphs take exact account of the conduit wall thickness and special considerations are given to the indeterminate state of strain in the corner region.

LOOKING BACKWARD AND FORWARD 39-19

MORTON O. WITHEY — Apr. 1943, pp. 385-388 (V. 39)

The Institute's president-elect (February 1943) surveys ACI performance and prospects for performance in wartime and the peacetime to come.

LONG SPAN CONCRETE ROOF CONSTRUCTION 39-20

C. H. MAYER — Apr. 1943, pp. 389-396 (V. 39)

Shows the reinforced concrete roof design used by the author during the last 25 years for economy and speed. It is of special interest in its minimum use of critical materials in these times. The notable feature of the design is a simple Howe truss whose top chord members support a continuous monitor for light and ventilation.

IMPACT RESISTANCE OF REINFORCED CONCRETE SLABS 39-21

RALPH W. KLUGE — Apr. 1943, pp. 397-412 (V. 39)

Impact tests of 15 reinforced concrete slabs indicated that the use of supplementary reinforcement in the form of a series of overlapping spiral coils increased their impact resistance by 1½ to approximately 2½ times with energy loads varying from 1400 ft-lb to 5000 ft-lb. The relative impact resistance with respect to weight per square foot of slab and weight of reinforcement in a square foot of slab was determined for various patterns of the bar reinforcement in the slab and for various thicknesses of slab. The tests were made at the National Bureau of Standards for the Maritime Commission.

EFFECT OF TIME OF HAUL ON STRENGTH AND CONSISTENCY OF READY-MIXED CONCRETE 39-22

GLENN C. COOK — Apr. 1943, pp. 413-428 (V. 39)

Strength and slump tests are reported for ready-mixed concrete mixed in stationary mixer and hauled in a standard truck-mixer-agitator for various periods up to 7 hr. One group of tests was conducted during early spring and another during summer to study effect of temperature. Wash analyses made on concrete samples before starting haul and at end of haul. Effect of retempering by adding water to restore lost slump was studied.

OREGON TESTS ON COMPOSITE (TIMBER-CONCRETE) BEAMS 39-23

CONDE B. McCULLOUGH — Apr. 1943, pp. 429-440, (V. 39)

Tests of timber-concrete beams were prompted by the desire of the Oregon State Highway Department to develop a short span highway bridge intermediate in cost between the untreated timber trestle and the reinforced concrete viaduct. The tests are briefly reported here. Important among the conclusions: The ultimate strength of a composite beam (of the type tested), suitably designed, is at least twice that for the same materials and the same dimensions independently employed. The composite bridge design developed is now represented by more than 180 structures with a total length of 20,000 ft.

FATIGUE TESTS OF LIGHTWEIGHT AGGREGATE CONCRETE BEAMS . . . 39-24

HARRY A. WILLIAMS — Apr. 1943, pp. 441-448 (V. 39)

Presents the results of a limited number of reversed and repeated loading tests of unreinforced concrete beams made with Haydite and Gravelite lightweight aggregates. True endurance limits were not determined but the results give an indication of the endurance strength for a limited number of repetitions.

THE PROPERTIES AND BEHAVIOR UNDERWATER OF PLASTIC CONCRETE 39-25

P. J. HALLORAN and K. H. TALBOT — June 1943, pp. 461-492 (V. 39)

This paper pioneers in the field of analyses of the physical characteristics of plastic concrete when placed under water. No endeavor is made to record the field procedures except insofar as they are related to the research as set up by observations, tests in the prototype, and in models. The conclusions are consistent with the limited number of repetitive readings. It suggests by observation of certain basic principles that greatly improved physical characteristics of concrete may be developed under water by modifying the field procedures to accommodate the indicated behavior from the numerious experiments.

It is the hope of the authors that observation of several of these principles which appear to extend the heretofore limited knowledge of this field of engineering may lead to continued use of tremie concrete for engineering problems that require accurate and intricate placing of a dense, impermeable, durable concrete.

PRESTRESSED CONCRETE DESIGN PRINCIPLES AND REINFORCING UNITS 39-26

HERMAN SCHORER — June 1943, pp. 493-528 (V. 39)

Discusses the steel stress limitation in ordinary reinforced concrete design and shows how working stresses may be increased by the use of monolithic, prestressed concrete construction. It gives a description of self-contained prestressed reinforcing units and points out the advantageous combination of high yield-point steel wire and high-early-strength concrete. A derivation of the elementary design principles is illustrated by examples. The theoretical conclusions are compared with some observations on prestressed prisms and test beams.

THE FUNCTION OF ENTRAINED AIR IN CONCRETE 39-27

HENRY L. KENNEDY — June 1943, pp. 529-544 (V. 39)

The use of air-entraining agents in portland cement concrete shows considerable promise, particularly in highway concrete where resistance to scaling is an important factor. The need for fundamental research regarding the mechanism by which entrained air functions is suggested and methods of tests are outlined.

Some results of exploratory investigations of the action of air-entraining agents on the individual constituents of concrete are reported. It is indicated that the action of air-entraining agents in cement paste differs materially from their action in concrete. The effect of air-entraining agents on neat cement paste suggests a probable maximum cement content of concrete, above which the beneficial effect of air-entraining agents may become negligible, their effect on strength remaining unchanged.

WIRE-WOUND PRESTRESSED CONCRETE PRESSURE PIPE 39-28

RAY B. CREPPS — June 1943, pp. 545-556 (V. 39)

Describes briefly the manufacturing of and a simplified design for a concrete shell reinforced by wrap-

ping a prestressed wire around it to give the pipe structural properties for water lines in which high hydrostatic pressures can be carried. A hint as to possible use of pipe of this type for culvert purposes is included.

BUREAU OF RECLAMATION PRACTICE IN DESIGN OF JOINTS FOR CONCRETE BUILDINGS 39-29

SAMUEL JUDD — June 1943, pp. 557-564 (V. 39)

An illustrated description of the design and construction practice of the Bureau of Reclamation in providing joints in reinforced concrete buildings: (1) between large power units; (2) at large changes in cross section; (3) at junctions between parts of structures on foundations of different bearing value; (4) at angles between portions of buildings; (5) where buildings are weakened by openings; (6) where concrete placing is interrupted.

THE PLASTICITY RATIO OF CONCRETE AND ITS EFFECT ON THE ULTIMATE STRENGTH OF BEAMS 39-30

V. P. JENSEN — June 1943, pp. 565-584 (V. 39)

The hypothesis is advanced that the stress-strain diagram for concrete under short-time loading may be idealized for certain purposes so as to consist of two linear parts, one representing elastic behavior and the other representing plastic behavior. The former is measured by the "modular ratio" which is defined as the ratio of the modulus of elasticity of steel to the initial modulus of elasticity of concrete. The latter is measured by the "plasticity ratio" which is defined as the ratio of the plastic strain to the total strain at rupture of the concrete. An empirical equation is given to express the relationship between the plasticity ratio and the compressive strength of concrete made with gravel or crushed stone aggregate. Formulas are derived for the ultimate strength of beams reinforced in tension only. From published results of tests of beams which have failed by compression, experimental evidence is presented which justifies the concept of the plasticity ratio as a function of the compressive strength of concrete.

ELECTRIC PRESTRESSING OF REINFORCING STEEL 39-31

KARL P. BILLNER and ROY W. CARLSON — June 1943, pp. 585-592 (V. 39)

In the electric method of prestressing, smooth reinforcing rods are stressed by being temporarily expanded by an electric current after the concrete has hardened. The rods are coated with a thermoplastic material such as sulfur which melts and relieves the bond only while the rods are temporarily heated by the electric current. While the rods are expanded, nuts are taken up at the ends a predetermined amount to provide the desired prestress. Two notable features of the method are (1) that bond is restored with cooling and resolidification of the sulfur coating and (2) that the quick heating of the rods does not warm the concrete appreciably. Interesting results of tests and trials are reported.

Proceedings V. 40

PLANNING FOR THE POSTWAR PERIOD 40-1

AMERICAN CONCRETE INSTITUTE COMMITTEE ON POSTWAR PLANNING — Sept. 1943, pp. 1-4 (V. 40)

Suggests matters for study by an appropriate Congressional agency. The report was prepared by a committee of the Institute's Board of Direction and was approved by the Board.

CHARTS AND A DIRECT METHOD FOR DESIGN OF CANTILEVER RETAINING WALLS 40-2

WILLIAM A. JONES — Sept. 1943, pp. 5-32 (V. 40)

Describes and illustrates a method for the design of retaining walls with special reference to the highway field. Included is a suggested classification of walls. It touches lightly on the selection of wall types and of earth pressure formulas and factors, and discusses and illustrates briefly the preparation of charts.

Both method and charts were developed and used by the author in a large bridge designing office and for the design of practically all wing walls of the numerous bridges of the Pennsylvania Turnpike, thereby saving design cost and facilitating the intense design pace of the project.

SUPPLEMENTARY DATA ON THE EFFECT OF CONCRETE AGGREGATE HAVING LOW THERMAL COEFFICIENT OF EXPANSION 40-3

J. C. PEARSON — Sept. 1943, pp. 33-40 (V. 40)

This is a continuation of the study reported in "A Concrete Failure Attributed to Aggregate of Low Thermal Coefficient," V. 38, p. 29. A limited number of tests were made on 2 x 2 x 10-in. bars containing two types of low coefficient aggregates and one type of silica pebbles, which were submitted to cycles of temperature changes from -20 F to room temperature. After about 50 cycles, bars containing the low coefficient aggregates lost 40 to 50 percent of their original modulus of elasticity whereas the bars containing silica pebbles lost only 2 or 3 percent of their original modulus. Expansions during these cycles were not large but that of the low coefficient aggregate bars was 3 or 4 times that of the silica pebble bars. After 100 cycles of temperature changes, the bars were submitted to freezing and thawing cycles of the same temperature range as before. The bars containing the low coefficient aggregates succumbed rapidly to the frost action while the silica bars were only moderately affected by the same treatment. The results lend further support to the conclusion of the earlier paper by the author, namely, that low thermal coefficient aggregates can be a source of danger in concrete exposed in cold climates.

REINFORCED CONCRETE CORNERS IN TENSION 40-4

C. J. POSEY and ORVILLE KOFOID — Sept. 1943, pp. 41-52 (V. 40)

Many concrete structures have corners which must resist bending moments that cause tension at the inside. Various ways of placing corner reinforcement for this loading condition are discussed, and the results of comparative tests are described which show that certain new designs are superior to currently standard designs in strength, toughness, and resistance to cracking.

CHART FOR THE DESIGN AND ADJUSTMENT OF CONCRETE MIXES. 40-5

HOWARD E. BURR — Sept. 1943, pp. 53-60 (V. 40)

The chart presented permits the direct expression of the three variables of a concrete mix. These variables, cement, aggregate, and water are expressed in amounts per cubic yard of concrete, the expressions being given in those terms made familiar through long usage by the man in the field. The chart lends itself readily to the solution of the problems encountered in the adjustment of a mix.

PROPOSED RECOMMENDED PRACTICE FOR THE DESIGN OF CONCRETE MIXES 40-6

COMMITTEE 613 — Nov. 1943, pp. 93-116 (V. 40)

Supersedes 38-14
Superseded by 41-26

The nature of the report is implicit in the title. With three amendments and some editorial revision (see Apr. 1944 ACI Journal News Letter p. 3) the report was approved for adoption as an ACI Standard and ratified by letter ballot July 28, 1944.

PROPOSED SPECIFICATIONS FOR CONCRETE PAVEMENTS AND BASES 40-7

COMMITTEE 617—Nov. 1943, pp. 117-144 (V. 40)
Supersedes 37-17
Superseded by 41-27

These specifications apply to the construction of portland cement concrete pavement and base under normal conditions, including the preparation of the subgrade, and shall govern unless modified by special provisions to take into account unusual conditions of traffic, subgrade, drainage, exposure, and other factors. (Adopted by the ACI convention, 1944, and ratified by letter ballot as an ACI Standard July 28, 1944).

SOME PROPERTIES OF PORTLAND POZZOLANA CEMENTS 40-8

GEORGE L. KALOUSEK and C. H. JUMPER—Nov. 1943, pp. 145-164 (V. 40)

An investigation was made of 12 portland-pozzolan, (including 2 laboratory blends), 1 natural and 2 standard portland cements. The cements were tested for part, or all, of the following: strengths, resistance to combinations of cycles of freezing, thawing, drying, and soaking; also length changes during alternate wetting and drying, resistance to sulfate solutions, linear changes in autoclave tests, and heats of hydration. Chemical analyses were also made.

The commercial portland-pozzolan cements showed strengths approximating, and in some cases exceeding, those required by specifications for standard portland cements. Nearly the same linear changes were shown by all the cements in alternate wetting and drying tests. The portland-pozzolan cements showed better resistance to a 10 percent sodium sulfate solution than the portland cements, at 4 weeks, but at later ages the results tended to be the same. The heats of hydration and resistance to cycles of freezing, thawing and drying [65 C (150 F)] of the portland-pozzolan cements did not compare unfavorably with those of the standard portland cements.

TESTS OF MASONRY CEMENTS 40-9

GEORGE W. WASHA—Nov. 1943, pp. 165-172 (V. 40)

Presents results of tests made on seven masonry cements. Properties reported are: water retention, water repellency, tensile and compressive strength, linear changes due to autoclaving and to three different storage conditions. Strength and linear change properties are reported to 5 years.

PROPOSED RECOMMENDED PRACTICE FOR THE CONSTRUCTION OF CONCRETE FARM SILOS 40-10

COMMITTEE 714—Jan. 1944, pp. 189-204 (V. 40)
Superseded by 43-7

ACCELERATED TESTS OF CONCRETE EXPANSION DUE TO ALKALI-AGGREGATE REACTION 40-11

ROY W. CARLSON—Jan. 1944, pp. 205-212 (V. 40)

Reports length changes up to 2 years in mortars containing 22 different aggregates. Shows the accelerating effects of sodium hydroxide added to the mixing water and of storage temperatures of 110 and 150 F. Although it appears that the main effect of the higher temperatures is to hasten the expansion due to reactive aggregates, it remains to be proved whether some aggregates such as quartz, which cause expansion at the higher temperatures, will ever cause expansion at 70 F or less.

Among the aggregates tested, all those containing silica caused some expansion at the higher temperature, and conversely aggregates lacking in silica caused no expansion. Greatest expansion of 2 percent in length was caused by only 5 percent of an aggregate containing opaline silica blended with 95 percent of a nonreactive aggregate.

STUDIES RELATING TO THE MECHANISM BY WHICH THE ALKALI-AGGREGATE REACTION PRODUCES EXPANSION IN CONCRETE 40-12

W. C. HANSEN—Jan. 1944, pp. 213-228 (V. 40)

The expansion and cracking of certain concrete structures have been attributed to a reaction between the aggregate and the alkali hydroxides produced by the hydration of the cement minerals. An hypothesis of the mechanism by which this reaction produces expansions in concrete is given. This hypothesis is based on the reaction of alkali hydroxides with opaline silica in the aggregate producing alkali silicates which because of the semipermeable nature of the hardened cement paste give rise to osmotic pressures. Several lines of evidence support this hypothesis, and the hypothesis appears to explain satisfactorily why opaline silica does not produce abnormal expansions through reaction with calcium hydroxide.

ALKALI ETCHING TESTS ON CONCRETE AGGREGATES 40-13

WILLARD H. PARSONS and HERBERT INSLEY—Jan. 1944, pp. 229-244 (V. 40)

A test for determining the reactivity of an aggregate with high-alkali cements is described, which consists of microscopic examination of polished surfaces of rocks and minerals after etching in various alkaline hydroxide and sulfate solutions. Pure opal, opaline chert and opaline limestone are readily etched, while volcanic glass, certain feldspars, chalcedony, calcite, and dolomite are slightly etched under some of these test conditions. Photomicrographs of etched rocks and minerals are included.

CONCRETE PROBLEMS IN THE CONSTRUCTION OF GRAVING DOCKS BY THE TREMIE METHOD 40-14

W. MACK ANGAS, E. M. SHANLEY, and J. A. ERICKSON—Feb. 1944, pp. 249-280 (V. 40)

Points out the advantages of the tremie method of placing concrete, and the unrivalled speed which the method affords in the construction of large concrete dry docks. Describes in detail the numerous unusual problems in mixing, transporting, and placing 450,000 cu yd of concrete which arose when a central mixing plant, concrete pumps, and tremie pipes were employed for large underwater construction, and denote the attempts, largely successful, to solve these problems. A general description of the methods used in the construction of dry docks is given, but normal features of the operations have been slighted in favor of the more useful discussion covering the difficulties encountered and their solution.

TESTS OF GASOLINE-RESISTANT COATINGS 40-15

J. C. PEARSON—Feb. 1944, pp. 281-292 (V. 40)

Coatings that may serve as gasoline-resistant linings for concrete storage tanks are tested by applying them to small concrete containers and sealing the latter with plate glass covers drilled with small holes convenient for stoppering. Containers are filled with aviation gasoline and stored under constant temperature and humidity conditions. Periodic weighings give percolation losses and establish the degree of impermeability in a short period. Durability of coatings in long-time contact with gasoline is indicated by constancy of percolation rates.

CONSTRUCTION JOINT CLEAN-UP METHOD AT SHASTA DAM 40-16

C. S. RIPPON — Feb. 1944, pp. 293-304 (V. 40)

Specifications for Shasta Dam and Power Plant on the Sacramento River near Redding, Calif., incorporated a new method for treatment of horizontal construction joints. The method required a 2-in. covering of moist sand spread on the concrete as soon as the surface had hardened sufficiently to withstand the necessary traffic. Clean-up required before the

placement of the next concrete lift consisted of removing the wet sand, which also served as a curing medium, and washing with high velocity air-water jets. This method was abandoned after 9 months' operation because of high cost of handling the sand and interruption of concrete placement schedules by use of "hi-lines" to distribute sand. After abandoning the sand method, all joints were cured with water sprays and wet sand blasted just prior to placement of the next concrete lift.

PROPOSED MINIMUM STANDARD REQUIREMENTS FOR PRECAST CONCRETE FLOOR UNITS 40-17

COMMITTEE 711 — Feb. 1944, pp. 305-320 (V. 40)

Superseded by 43-6

THE FUTURE OF THE INSTITUTE 40-18

MORTON O. WITHEY — Apr. 1944, pp. 397-400 (V. 40)

An address by the retiring president at the 40th annual ACI Convention. It reviews the ACI past and points to that expansion of its work which is needed for further growth and development.

A DEVICE FOR DETERMINING THE DEPTH OF SURFACE CRACKS IN CONCRETE 40-19

R. B. YOUNG — Apr. 1944, pp. 401-408 (V. 40)

A device is described consisting essentially of a pressure tank, an air pump, and a pressure gage, together with pipes, valves and fittings by which a dye solution is forced into the crack to be explored. Then by drilling, the crack is followed inward until it is bottomed. The depth of the crack is established by a pressure test. Some results obtained using the device are reported.

HIGH PRESSURE STEAM CURING 40-20

COMMITTEE 716 — Apr. 1944, pp. 409-416 (V. 40)

The committee defines high-pressure steam curing in terms of performance in reduced shrinkage of concrete products; arrives at 11 conclusions as to the characteristics of concrete products cured by high-pressure steam and appends a considerable list of references as background for the report.

NAVY INSTALLATIONS OF PROTECTIVE LININGS FOR PRESTRESSED CONCRETE TANKS CONTAINING LIQUID FUELS 40-21

MORRIS A. SPAMER — Apr. 1944, pp. 417-428 (V. 40)

Reviews the experiences of the Bureau of Yards and Docks in the application of about 2⅓ million sq ft of protective linings for concrete tanks to contain diesel oil and aviation gasoline. As other literature on this subject deals almost entirely with research work, this paper reports field experience with a summary of results to date in this comparatively new field particularly as the lining program by the Navy is the only one of considerable magnitude that has presently been completed.

CONCRETE GASOLINE TANKS FOR MILITARY USE 40-22

E. R. SHEPARD — Apr. 1944, pp. 429-440 (V. 40)

As a result of the critical shortage of steel sheet and plate, a number of tanks for the bulk storage of aviation gasoline have been built of concrete, in which various methods of sealing the tank against the leakage of gasoline are being tested. Two tanks are water sealed, one by the double wall method and the other by submersion in permanent ground water. The effect of the extraction of alkaline salts from the bare tank walls on the stability of the stored gasoline is yet to be determined. A number of tanks with welded sheet steel linings are in service, in some of which interior corrosion has developed where highly corrosive water is used for operating the tanks by the displacement method. Several small concrete tanks built by the Defense Plant Corporation without any interior lining other than a brushed-on coat of cement grout are in successful operation.

WAR-BORN CONCRETE PRODUCTS . . 40-23

C. F. MOORE — Apr. 1944, pp. 441-456 (V. 40)

Records how the necessity for the conservation of critical materials — notably steel — was met with ingenuity and resourcefulness by the concrete products industry. Small individual steel savings when multiplied by larger production resulted in conserving enormous quantities.

Over and above the 200,000,000 odd concrete masonry units used in temporary war housing, 185 manufacturers in 35 states produced well over 3,000,000 precast products of one kind or another during 1943. These products described, and many of them illustrated, will in many instances carry on into peacetime production.

FACTORS AFFECTING THE THERMAL EXPANSION OF CONCRETE AGGREGATE MATERIALS 40-24

WILLARD H. PARSONS and WALTER H. JOHNSON — Apr. 1944, pp. 457-468 (V. 40)

As a part of a study of the properties of concrete aggregates, thermal expansion determinations were made on 137 specimens of aggregate materials and single crystals by the optical interferometer method over the temperature range −4 to +140 F. The thermal expansivities of most aggregate materials are close to or within the range of expansivities of hardened portland cements. Crystal orientation, rock texture, and composition are discussed with regard to their effect on the thermal expansion of aggregate materials and their relation to the durability of concrete.

TESTS OF CONCRETE CONTAINING AIR-ENTRAINING PORTLAND CEMENTS OR AIR-ENTRAINING MATERIALS ADDED TO BATCH AT MIXER 40-25

H. F. GONNERMAN — June 1944, pp. 477-508 (V. 40)

Presents some of the more significant results obtained in extensive laboratory studies made in connection with the construction of 18 experimental road projects, and in several separate laboratory investigations conducted during the past 6 years with air-entraining portland cements, and with air-entraining materials added at the mixer. Concrete specimens from nearly every experimental road project and from all laboratory series were subjected to scaling and to freezing and thawing tests. These specimens consisted of slabs made in the field from the concrete used in the pavement, of cores drilled from the pavement, and of many prisms made in the laboratory from the cements used in the roads. The laboratory studies included also many slabs and prisms made with various cements.

Resistance to scaling, and to freezing and thawing while immersed, was markedly improved when the concrete was made with air-entraining portland cements, or with air-entraining materials added at the mixer. Increase in air content of the concrete caused reductions in flexural and compressive strength. Each percentage point increase in air content reduced the modulus of rupture 2 to 3 percent and the compressive strength 3 to 5 percent. Taking into account both strength and resistance to freezing and thawing, excellent performance was obtained when the total amount of entrained air in the fresh concrete was about 3 percent, or about 2 percentage points higher than that of concrete without air-entraining additions. With this percentage of air, the loss in strength was generally not more than 6 percent in flexure and 10 percent in compression. Higher air contents than 3 percent caused greater reductions in strength without any compensating increase in resistance to scaling and to freezing and thawing. The performance under service conditions of experimental paving projects constructed since 1938 with air-entraining portland cements parallels the results of the laboratory studies.

Supplementary data — H. F. Gonnerman — Nov. Suppl. 1944.

See also 40-26, 41-5, 42-4, 42-15, and 42-24 to 42-38.

CONCRETES CONTAINING AIR-ENTRAINING AGENTS 40-26

A SYMPOSIUM — June 1944, pp. 509-572 (V. 40)

Contributions by Frank H. Jackson, Henry L. Kennedy, Harmon S. Meissner, Myron A. Swayze, Donald R. MacPherson, George L. Lindsay, Harry F. Thomson, Robert A. Burmeister, Stanton Walker, Raymond E. Davis, Guy H. Larson, Joseph H. Chubb, R. T. Sherrod, J. F. Barbee, F. V. Reagel, reporting laboratory and field experiences with concretes containing air-entraining agents — and problems still to be solved.

See also 40-25, 41-5, 42-4, 42-15, and 42-24 to 42-38.

FREEZING AND THAWING TESTS OF CONCRETE MADE WITH DIFFERENT AGGREGATES 40-27

STANTON WALKER — June 1944, pp. 573-580 (V. 40)

Summarizes information on freezing and thawing tests of concrete made with different coarse aggregates and describes a "durability factor" which may be calculated as a function of the cycles of freezing and thawing and their effect on the modulus of elasticity of the concrete as measured dynamically.

Proceedings V. 41

PREPARATION OF TECHNICAL PAPERS 41-1

W. D. BIGLER — Sept. 1944, pp. 1-12 (V. 41)

The author deplores the inadequate training of many engineers in English composition — their poor sense of literary form, their halting and ineffectual attempts to express themselves with precision and clarity. He quotes many published examples of the faults he finds; suggests improved passages, and further, on the constructive side, recommends a course of study.

THE EFFECTIVENESS OF VARIOUS TREATMENTS AND COATINGS FOR CONCRETE IN REDUCING THE PENETRATION OF KEROSENE...... 41-2

F. B. HORNIBROOK — Sept. 1944, pp. 13-20 (V. 41)

Measurements were made of the penetration of kerosene under a 12 ft pressure head into discs of concrete which had received various treatments or coatings. The tests were classified into seven groups as follows: (1) reference concrete, (2) integral admixtures, (3) sodium silicate and magnesium fluosilicate treatments, (4) plaster coats, plain and with admixtures, (5) magnesium oxychloride type coatings, (6) linseed oil and spar varnish coatings, and (7) synthetic plastic and latex coatings. Comparisons of the relative rates of penetration of kerosene into the specimens of each group are given, together with a discussion of various other properties of each group.

TWO-WAY REINFORCED CONCRETE SLABS 41-3

PAUL ROGERS — Sept. 1944, pp. 21-36 (V. 41)

Design formulas for two-way reinforced concrete slabs are given in the ACI Building Regulations (318-41). No derivations, however, are included for these formulas. While outstanding scientific works are at hand dealing with this problem (Timoshenko, Westergaard, etc.), it is obvious that they are out of reach for the average office designer. The simplified method presented, developed by Dr. Henri Marcus, may clarify certain principles and help visualize the effect of the torsional moments.

REACTIVITY OF AGGREGATE CONSTITUENTS IN ALKALINE SOLUTIONS 41-4

LEONARD BEAN and J. J. TREGONING — Sept. 1944, pp. 37-52 (V. 41)

The relative order of reactivity of 12 types of aggregate constituents to alkali hydroxide solutions was determined by an accelerated test at 122 C, to be as follows: opal, chalcedony, pitchstone, rhyolite, basalt, magnesite, obsidian, calcite, limestone, dolomite, microcline, and oligoclase. The carbonates were more reactive to KOH than NaOH. The feldspars and glass bearing rocks were more susceptible to attack by NaOH. Reactivity to carbonate and sulfate solutions was found to be negligible under the conditions chosen. Quantitative data on the solubility of the materials in hydroxide and carbonate solutions at 21 C are given. These agree with the results of the accelerated test. These data shed light on alkali reactivity under the conditions of the laboratory tests used, but make no attempt to predict expansion of concrete on the basis of these tests alone.

ADMIXTURES FOR CONCRETE...... 41-5

COMMITTEE 212 — Nov. 1944, pp. 73-88 (V. 41)

With the aim of providing a perspective of the field of admixtures for the use of the engineer confronted with a need of modifying concrete to meet special requirements of a given job, Committee 212 has classified admixtures into nine broad groups. Discussions are given of the factors which might indicate the usefulness of admixtures of each group, and of the important effects which may ordinarily be expected from the use of materials of each group. The nine groups are as follows: (1) accelerators, (2) air-entraining agents, (3) gas-forming agents, (4) natural cementing materials, (5) pozzolanic materials, (6) retarders, (7) water-repelling agents, (8) workability agents, and (9) miscellaneous.

See also 40-25, 40-26, 42-4, 42-15, 42-24 to 42-38, and 51-5

THE EFFECT OF ALKALIES IN PORTLAND CEMENT ON THE DURABILITY OF CONCRETE........ 41-6

BAILEY TREMPER — Nov. 1944, pp. 89-104 (V. 41)

Field observations, now confirmed by laboratory tests, have demonstrated the reactive character of concrete aggregates derived from lavas of the volcanic cone of Mt. Rainier, Wash. Deterioration has been universal in concrete containing such aggregates and high-alkali cement but when low-alkali cements have been used structures are in excellent condition at ages up to 19 years. The rate of retrogression is dependent on the severity of climatic conditions.

Disintegration of another type is progressing in certain structures in eastern Washington. Reactivity of the aggregates used is not exhibited in the sealed-can test but may be demonstrated by a combination of moist storage followed by cycles of freezing and thawing. The main, if not the sole, factor influencing disintegration in this test is the content of alkalies in the cement whether they are present initially or are added at the time of mixing.

These results point to the need of limiting the alkali content of cements for satisfactory use with many aggregates in Washington.

THE EFFECT OF CURING CONDITIONS ON COMPRESSIVE, TENSILE AND FLEXURAL STRENGTH OF CONCRETE CONTAINING HAYDITE AGGREGATE 41-7

E. B. HANSON, Jr. and W. T. NEELANDS — Nov. 1944, pp. 105-116 (V. 41)

Lightweight concrete has been given a severe test in the U. S. Maritime Commission's present concrete ship construction program. In its use, problems arose that could not be solved by the application of sand-gravel concrete data. This paper describes some of the strength characteristics of this type of concrete. Data are consistent in showing that rapid moisture loss from Haydite concrete produces a serious retrogression in the tensile and flexural strengths, regardless of the length of moist curing. This decline in strength, caused by drying shrinkage stresses developing in the outer fibers as the moisture content becomes unbalanced, is of a temporary nature and apparently can be curbed

by the application of paint or membrane seal following the moist curing period. The drying shrinkage may well contribute to serious cracking in some types of structures if control is not maintained.

A LIMITED INVESTIGATION OF CAPPING MATERIALS FOR CONCRETE TEST SPECIMENS 41-8

THOMAS B. KENNEDY — Nov. 1944, pp. 117-128 (V. 41)

An investigation was made of the influence of type and age of cap on the apparent strength of concrete cylinders. The capping materials tested consisted of two types of commercial sulfur-silica compounds and two commercial plasters which had been in general use for this purpose. A total of 252 tests were made of concrete ranging in strengths from 2800 to 7500 psi.

The results indicate that the age of the caps has an important bearing on the apparent strength of the concrete with 1 hr being the minimum time required for the best of the materials to develop the full strength of the concrete.

CONCRETE OPERATIONS IN THE CONCRETE SHIP PROGRAM 41-9

LEWIS H. TUTHILL — Jan. 1945, pp. 137-180 (V. 41)

Describes only briefly the hulls constructed in the concrete ship program of the U. S. Maritime Commission but goes into more detail in connection with problems encountered and their solution in the course of these concrete operations. Construction joint procedure, lightweight aggregate concrete and mix control, handling, placing and vibration practice, curing, testing, and repair problems are described in the belief that much of this information is applicable to any concrete work of high standard. Design of hulls is not discussed except as construction is affected. The ships have not been in service sufficiently long to justify much discussion of their performance or durability.

FULLY AND PARTLY PRESTRESSED REINFORCED CONCRETE 41-10

P. W. ABELES — Jan. 1945, pp. 181-216 (V. 41)

In this paper it is intended to show the distinction between fully and effectively partly prestressed concrete, employing high strength steel. The various systems and methods are described, "pre-stretching" and "post-stretching" being distinguished. The losses of the initial prestress are discussed and formulas are derived for the factor of safety against cracking and for the minimum stretching force to ensure "full" prestressing, to be reduced for "partial" prestressing to such extent that dangerous cracks are avoided. Published comparative test results of prestressed and conventionally reinforced beams are discussed and some new data are presented regarding preliminary comparative tests on beams reinforced with high tensile wire. It is shown that a partly prestressed beam, having a reinforcement of about one fifth of that required for mild steel, behaves similarly to a conventionally reinforced beam, when under working load, and similarly to a fully prestressed beam (i.e. remaining crackless), when the load is removed.

AN INSTRUMENT AND A TECHNIC FOR FIELD DETERMINATION OF THE MODULUS OF ELASTICITY AND FLEXURAL STRENGTH OF CONCRETE (PAVEMENTS) 41-11

BARTLETT G. LONG, HENRY J. KURTZ, and THOMAS A. SANDENAW — Jan. 1945, pp. 217-232 (V. 41)

An instrument for determination of the dynamic modulus of elasticity of concrete, in situ, is described. Test results are represented which show (a) the comparison of test values of E, obtained by various older methods, with that obtained with the new instrument; and (b) the relationship of such values to the flexural strength of concrete. It is concluded that adoption of the new method and technic is justified, and that widespread use of the new instrument would eliminate the necessity for casting field specimens during construction (except perhaps for day-to-day control purposes) or of removing costly "samples" from completed works. A method for determining the thickness of concrete pavements is briefly discussed. A rather extensive bibliography is included.

A WORKING HYPOTHESIS FOR FURTHER STUDIES OF FROST RESISTANCE OF CONCRETE 41-12

T. C. POWERS — Feb. 1945, pp. 245-272 (V. 41)

Basic information is given on the freezing of water in concrete. From this information and other published material an explanation of the mechanism of the action of frost on concrete is developed. The explanation takes into account such factors as the degree of saturation of the concrete, the permeability and strength of the concrete, hydraulic pressures generated during freezing, and air-filled cavities. It is suggested that the hypothesis be made the basis of further laboratory studies of the action of frost in concrete.

PROPOSED TEST PROCEDURE TO DETERMINE RELATIVE BOND VALUE OF REINFORCING BARS 41-13

COMMITTEE 208 — Feb. 1945, pp. 273-292 (V. 41)

Introduced with a statement by the chairman, the report represents substantial agreement in Committee 208 and was approved by the ACI Standards Committee for publication as information in a preliminary period of discussion and trial. The "foreword" and preliminary discussion were prepared after the committee vote was taken and do not necessarily reflect accurately the points of view of individual committee members.

EFFECT OF TYPE OF BAR ON WIDTH OF CRACKS IN REINFORCED CONCRETE SUBJECTED TO TENSION 41-14

DAVID WATSTEIN and NORMAN A. SEESE, Jr. — Feb. 1945, pp. 293-304 (V. 41)

Eight types of reinforcing bars were tested to determine the effect of various kinds of deformations on width of cracks in reinforced concrete subjected to tension. The effect of repeated application of load on the width of cracks was also determined for two of the bars. The bonding efficiency of the bars was determined with a supplementary series of tensile specimens. For the most efficient type of bar, the width of cracks was less than 50 percent of that found for a plain round bar, when both bars carried a stress of 40,000 psi. A fair correlation was found between the width of cracks and the elongation at a given load measured in the tests of bonding efficiency. The width and spacing of cracks decreased, in general, with increasing bearing area of lugs on reinforcement bars.

CRACKING AND TEMPERATURE CONTROL OF MASS CONCRETE ...41-15

CLARENCE RAWHOUSER — Feb. 1945, pp. 305-348 (V. 41)

Presents a discussion of certain characteristics of mass concrete which have assumed increased importance in recent years by reason of more rapid construction with modern equipment of extremely large concrete dams. Understanding of the factors affecting the temperature and the thermal stresses of mass-concrete structures is necessary if advantage is to be taken of control measures to prevent unfavorable conditions. Some of the more important factors are presented which combine to establish controlling conditions of temperature, volume change, and crack development. A section on temperature computations is included which presents methods of evaluating the effects of imposed conditions and of determining the nature and extent of the temperature control required.

CONCRETE CURING METHODS 41-16

ASTM STANDARDS — Feb. 1945, pp. 349-356 (V. 41)

Through the courtesy of the American Society for Testing Materials, which, in deference to ACI activity in the realm of field practice, withdrew its standards for curing portland cement concrete, (under the original jurisdiction of the ASTM Committee C-9, Concrete and Concrete Aggregates) ACI here republishes the latest ASTM standards on this subject, as interim information pending the completion of the work of ACI Committee 612, Recommended Practice for Curing Concrete.

PRESIDENTIAL ADDRESS TO AMERICAN CONCRETE INSTITUTE 41-17

R. W. CRUM — Apr. 1945, pp. 437-440 (V. 41)

The retiring president discusses the responsibility of Institute members and others engaged in technical advancement in establishing a peaceful world in which such advancement may continue.

PRECAST CONCRETE PIT SHEETING.41-18

JACOB FELD — Apr. 1945, pp. 441-452 (V. 41)

The development of lightweight concrete slabs in place of wood planks for pit or box sheeting eliminates future settlements of underpinned structures when the buried sheeting rots. Practical use has demonstrated that concrete planks add little to the cost of such work. A summary of the history of box sheeting and of the various types used shows the possibilities for the use of concrete in this phase of construction work.

A PRACTICAL PROCEDURE FOR RIGID FRAME DESIGN 41-19

D. R. CERVIN — Apr. 1945, pp. 453-472 (V. 41)

Moment distribution has appreciably simplified theoretical studies of rigid building frames but in itself is not always a practical office tool. Two-cycle moment distribution coupled with short-cuts in loading for maxima has reduced the time element in design procedure considerably but still leaves something to be desired for actual office usage. This paper attempts to carry the two-cycle method one step further, illustrating a procedure whereby any rigid frame can be completely designed within a time period that is economically feasible for average office usage.

DYNAMIC TESTING OF PAVEMENTS 41-20

GERALD PICKETT — Apr. 1945, pp. 473-492 (V. 41)

A theoretical analysis is made of the problem of the vibration of a pavement in contact with an elastic subgrade. The analysis shows that for each frequency of sustained vibration, waves may be propagated horizontally with three different velocities. The properties of the subgrade have little effect on the highest or the lowest of these three velocities but have considerable effect on the intermediate velocity. Near the origin the velocity of each wave may be greater or less than the velocity farther from the origin. The analysis indicates that the properties of both pavement and subgrade may be determined for any small region of the pavement by placing the source of sustained vibrations in that region.

ESTIMATING 28-DAY STRENGTH OF CONCRETE FROM EARLIER STRENGTHS — INCLUDING THE PROBABLE ERROR OF THE ESTIMATE 41-21

JACOB J. CRESKOFF — Apr. 1945, pp. 493-512 (V. 41)

Presents a method for estimating the 28-day strength of concrete from earlier strengths. Using a simple basic formula, its coefficient is adjusted by applying the method of least squares to a small number of data obtained from the mix under consideration. The method is noteworthy because it demonstrates that: only limited data are required for estimating purposes; earlier strengths in weighted combination can be used to estimate 28-day strength with increased accuracy; the formula can be computed accurately with a 10-in. slide rule; and, because it presents a criterion for judging accuracy of estimates.

SLABS SUPPORTED ON FOUR SIDES 41-22

R. L. BERTIN, JOSEPH DI STASIO, and M. P. VAN BUREN — June 1945, pp. 537-556 (V. 41)

The ACI Building Regulations for Reinforced Concrete provide, with respect to slabs supported on four sides, a method of analysis which reflects a clear picture of the elastic action of the structure, and, through the use of equivalent uniform load factors, permits the direct solution for bending moments and shears in the slabs and beams with the same coefficients as prescribed for one-way construction. To clarify the manner of presentation, the authors have prepared a suggested change of the entire Chapter 7 of the Code. While retaining all the original basic features, notation has been simplified, nonessential formulas and extraneous theory eliminated, and the regulations condensed to the fundamentals requisite for direct design. Final results are unchanged from those obtained through the use of the present 1941 regulations. In this paper, the proposed changes are stated and reasons for them given. Suggested regulations are presented in new form. Comparisons are shown to indicate conformity with theory. Finally, an analysis of a typical series of floor panels is given to illustrate the facility with which computations could be made under suggested changes. It is believed that engineers would find the suggested modification of this section of the Code simple and easy to apply.

BUILDING REGULATIONS FOR REINFORCED CONCRETE (ACI 318-41) 41-23

COMMITTEE 318 — June 1945, pp. 559-620 (V. 41)

Supersedes 37-5
Superseded by 44-1

RECOMMENDED PRACTICE FOR USE OF METAL SUPPORTS FOR REINFORCEMENT (ACI 319-42) 41-24

COMMITTEE 319 — June 1945, pp. 621-624 (V. 41)

Rescinded

This ACI Standard establishes the minimum requirements for number and location of supports and spacers under the following conditions: one-way slab construction; ordinary beam and joist construction; heavy beam and girder construction; and flat slabs (two-way and four-way systems).

The report makes no attempt to specify exact details and sizes for supporting devices but does give a specification covering the most common types.

RECOMMENDED PRACTICE FOR MEASURING, MIXING AND PLACING CONCRETE (ACI 614-42) 41-25

COMMITTEE 614 — June 1945, pp. 625-650 (V. 41)

Superseded by ACI 614-59

An outline of the best practices for measuring and mixing the ingredients for concrete and for placing the finished product. The specific objective of these recommendations is maximum uniformity, homogeneity, and quality of concrete in place.

Among the topics covered are: measurement and batching of aggregates; batching cement; water measurement; mixers; charging and discharge operations; mixing time; ready-mixed concrete; avoidance of separation in placing operations; vibration; and general considerations such as construction joints and forms. The report also includes illustrations of good and bad concreting practices.

RECOMMENDED PRACTICE FOR THE DESIGN OF CONCRETE MIXES (ACI 613-44) 41-26

COMMITTEE 613 — June 1945, pp. 651-672 (V. 41)

Superseded by 51-2

The most practical procedure for determining the final proportions of concrete for a given purpose is to select a trial mix that will require the least adjustment on the job. An outline of the six steps involved in the determination of a trial mix are given which include: selection of water-cement ratio; selection of slump limits; determination of largest size aggregate; selection of minimum percentage of sand; an estimate of amount of water; the computation and adjustments of the trial mix proportions.

The recommended procedure for making laboratory mix tests, as well as methods of determining the properties of the aggregates, are given in the appendix of the report.

Important factors determined by tests of concrete mixes include: relation between water-cement ratio and strength; variations in workability for various combinations of the materials; and the unit water contents and cement requirements for various aggregate gradings.

SPECIFICATIONS FOR CONCRETE PAVEMENTS AND BASES (ACI 617-44) 41-27

COMMITTEE 617 — June 1945, pp. 673-700 (V. 41)

Superseded by 47-49

These specifications apply to the construction of portland cement concrete pavement and base under normal conditions, including the preparation of the subgrade.

The subjects covered include: materials; proportions of materials based on design for minimum strength or based on uniform cement factor; measurement and handling of materials, mixing; high-early-strength concrete; subgrade preparation; forms; installation of joints and reinforcement; placing and finishing concrete; and curing.

SPECIFICATION FOR CAST STONE (ACI 704-44) 41-28

COMMITTEE 704 — June 1945, pp. 701-704 (V. 41)

Rescinded

A standard for the physical quality of cast stone with selection of specimens for testing and the methods of testing specified.

Proceedings V. 42

CONCRETE CONSTRUCTION IN THE NATIONAL FORESTS 42-1

CLIFFORD A. BETTS — Sept. 1945, pp. 1-12 (V. 42)

How U.S. Forest Service applies the fundamentals of good concrete without elaborate control measures to countless small, isolated jobs in the 175,-000,000 acres of National forests and along 100,000 miles of roads serving these areas, with pictures to show some of the variety of the work done.

LAPPED BAR SPLICES IN CONCRETE BEAMS 42-2

RALPH W. KLUGE and EDWARD C. TUMA — Sept. 1946, pp. 13-36 (V. 42)

An investigation was conducted to determine the general behavior and strength of lapped bar splices which varied in length and method of splicing. The maximum bond resistance developed in the splice and the slip of bar was determined for two types and sizes of reinforcement. The resulting data clearly illustrated the manner in which the stress was transferred from one lapped bar to the other and the relative merits of the two types of bars as well as the effectiveness of the two methods of splicing was shown.

TESTS OF PRESTRESSED CONCRETE PIPES CONTAINING A STEEL CYLINDER 42-3

CULBERTSON W. ROSS — Sept. 1945, pp. 37-48 (V. 42)

Tests were made on prestressed reinforced concrete pipes of a type containing a steel cylinder. Data were obtained by tests under hydrostatic pressure, in crushing and in bending. The mechanical properties of the several parts, and the strain changes of the pipes under load are reported.

FIELD USE OF CEMENT CONTAINING VINSOL RESIN 42-4

CHARLES E. WUERPEL — Sept. 1945, pp. 49-84 (V. 42)

The results obtained from 22,398 test specimens manufactured in connection with extensive construction, principally during 1941-1944, are presented together with a discussion of the experience with handling concrete containing over 2,000,000 barrels of Vinsol resin cement during this period in 168 structures. Comparisons are drawn between concrete made with plain cement and with cement interground with Vinsol resin as they affect the compressive and flexural strength, the unit weight and the mixing, placing, and finishing operations.

See also 40-25, 40-26, 41-5, 42-15, and 42-24 to 42-38.

MAINTENANCE AND REPAIR OF CONCRETE BRIDGES ON THE OREGON HIGHWAY SYSTEM...... 42-5

G. S. PAXSON — Nov. 1945, pp. 105-116 (V. 42)

Descripes types of concrete disintegration and methods and materials used in Oregon, for repair and replacement and for protection against further deterioration.

SHOULD PORTLAND CEMENT BE DISPERSED? 42-6

T. C. POWERS — Nov. 1945, pp. 117-140 (V. 42)

A development of definitions of wetting and dispersion is followed by a discussion of dispersion of portland cement. From elementary principles it appears that a wetting agent is unnecessary, for portland cement is highly hydrophilic.

The dispersed state of portland cement in water is defined as that state in which interparticle attraction in a fresh paste is absent or so weak that it has no appreciable effect on the physical properties of the fresh paste. Experiments and reasoning from general principles indicate that dispersion would be undesirable because it would increase the rate and amount of sedimentation and promote particle-size segregation in cement paste; it would destroy the plasticity of the pastes and give them the properties of a fluid, a probably undesirable change; it would have no beneficial effect on rate of hydration during the early stages through an increase in exposed surface area because the whole surface is normally exposed to water even when the particles are flocculated.

A reduction in interparticle attraction short of actual dispersion should reduce the water required for a given slump, but it would not improve workability except in unusually rich mixes. It would increase bleeding.

Air entrainment requires an increase in paste content and reduction of water content to maintain a given slump. It reduces strength but improves frost resistance. It improves workability and reduces bleeding.

Air entrainment together with some reduction in interparticle attraction affects paste content and water requirement in the same way as air entrainment alone, but the increase in paste content is smaller and the reduction in water content is greater than when there is no reduction in interparticle attraction. Air entrainment offsets the undesirable effects of reducing interparticle attraction on plasticity and reduces bleeding.

Some agents do not affect the chemical processes of hardening; their effects on strength can be predicted from the voids-cement ratio. Others tend to

retard hydration unless they contain an accelerating agent. Such agents have different effects with different cements.

AN INVESTIGATION OF THE STRENGTH OF WELDED STIRRUPS IN REINFORCED CONCRETE BEAMS . . . 42-7

ORESTE MORETTO — Nov. 1945, pp. 141-164 (V. 42)

The results of the tests of 44 beams of reinforced concrete with stirrups welded to the longtitudinal reinforcement are presented. The beams were designed in such a way as to produce failure by diagonal tension. Variables including the size and inclinaation of the stirrups, type of concrete and ratio of longitudinal reinforcement are studied. A comparison of the strength of welded stirrups with that of loose stirrups, as reported from former tests on web reinforcement, is attempted.

SHRINKAGE STRESSES IN CONCRETE 42-8

GERALD PICKETT — Jan. 1946, pp. 165-204, Feb. 1946, pp. 361-400 (V. 42)

Theoretical expressions for deformations of concrete beams and slabs that occur during the course of drying and expressions for distribution of the accompanying shrinkage stresses are derived in Part 1. These expressions are derived on the assumption that the laws governing the development of shrinkage stresses in concrete during drying are analogous to those governing the development of thermal stresses in an ideal body during cooling. Three cases are considered:

(a) slab or beam drying from one face only;
(b) slab or beam drying from two opposite faces; and
(c) prism drying from four faces.

The applicability of the equations to concrete is considered in Part 2. It is shown that the course of shortening of prisms is in good agreement with the theoretical equations and that from a test on one prism the shortening versus period of drying of other prisms of the same material differing in size and number of sides exposed to drying can be predicted with fair accuracy if the differences in size are not too great. However, it is shown that the theory must be modified to take into account inelastic deformation and to permit the supposed constants of the material to vary with moisture content and size of specimen if the theory is to be in agreement with all results on all types of specimen of a given concrete.

Various tests are described which, when used in conjunction with the theory, provide a means for studying some of the more fundamental properties of concrete and for predicting the performance of concrete under some conditions in the field.

FLOATING BLOCK THEORY IN STRUCTURAL ANALYSIS 42-9

STANLEY U. BENSCOTER — Jan. 1946, pp. 205-228 (V. 42)

A process of reaction distribution is developed for the purpose of calculating reactions beneath hinged floating blocks. Application to hinged base slabs is illustrated. The analogous correspondence to the process of moment distribution is explained by using the column analogy.

SHRINKAGE AND PLASTIC FLOW OF PRESTRESSED CONCRETE 42-10

HOWARD R. STALEY and DEAN PEABODY, Jr. — Jan. 1946, pp. 229-244 (V. 42)

Presents the results of shrinkage and plastic flow measurements on prestressed and unstressed specimens for the duration of a year. Stored at 70 F and 50 percent relative humidity the shrinkage of unstressed specimens reached maximum values of 8.7 X 10^{-4} in. per in. for the concrete and 6.5 X 10^{-4} for shotcrete. After 10 days the shotcrete shrinkage was about 75 percent of the concrete strains.

The loaded specimens were stressed to approximately 930 psi (low), 1500 psi (intermediate), and 2400 psi (high) for concrete and shotcrete whose ultimate compressive strengths were 4900 psi and 4500 psi, respectively. As shrinkage and plastic flow occurred these stresses decreased until, at 1 year, the stresses in the concrete were 25 to 33 percent their initial values and the stresses in the shotcrete were about 43 percent of the initial. Plastic flow is defined as the difference between the total strain of the loaded specimen and the shrinkage strain of the unstressed specimen during the same time interval. Plastic flow is assumed equal to the stress multiplied by a flow coefficient **c**. At 380 days the flow coefficients varied from 64 X 10^{-8} to 79 X 10^{-8} for the concrete and from 50 X 10^{-8} to 61 X 10^{-8} for the shotcrete. For the low stress specimens the shotcrete coefficient is 90 percent of the concrete; for the other two stresses the shotcrete coefficient is about 75 percent that of the concrete.

PROPOSED MINIMUM STANDARD REQUIREMENTS FOR PRECAST CONCRETE FLOOR UNITS 42-11

COMMITTEE 711 — Jan. 1946, pp. 245-260 (V. 42)

Superseded by 43-6

PROPOSED RECOMMENDED PRACTICE FOR THE CONSTRUCTION OF CONCRETE FARM SILOS 42-12

COMMITTEE 714 — Jan. 1946, pp. 261-264 (V. 42)

Superseded by 43-7

MAINTENANCE OF HEAVY CONCRETE STRUCTURES, MINNESOTA POWER AND LIGHT COMPANY PRACTICE . . 42-13

CLAY C. BOSWELL and ALBERT C. GIESECKE — Feb. 1946, pp. 277-288 (V. 42)

The practice of The Minnesota Power & Light Co. in repairing and restoring a concrete dam is described and illustrated and comparisons made with a much older structure, which has had no repair cost because construction methods were better.

TWO SPECIAL METHODS OF RESTORING AND STRENGTHENING MASONRY STRUCTURES 42-14

JOE W. KELLY and B. D. KEATTS — Feb. 1946, pp. 289-304 (V. 42)

Structures and foundations damaged by weather, erosion, scour, or settlement have been restored and strengthened by ingenious methods involving the pumping of cement-base stabilizing material into small interstices and the filling of larger spaces by aggregate which is then embedded in the stabilizing material under pressure. Herein are described several applications of the methods to various structures including bridge piers and abutments, reservoirs, dams, and underwater construction.

LABORATORY STUDIES OF CONCRETE CONTAINING AIR ENTRAINING ADMIXTURES 42-15

CHARLES E. WUERPEL — Feb. 1946, pp. 305-360 (V. 42)

The effects of the incorporation of each of nine different air-entraining admixtures in concrete were investigated by the making of a large number of batches of concrete under carefully controlled laboratory conditions. The results of tests on the plastic and hardened concrete specimens from batches made in parallel with and without each admixture are presented and discussed. An interpretation of the significance of the data and their application to the successful use of air entrainment in concrete is given.

See also 40-25, 40-26, 41-5, 42-4, and 42-24 to 42-38.

PROPOSED MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES 42-16

COMMITTEE 315 with the cooperation of the CONCRETE REINFORCING STEEL INSTITUTE — Apr. 1946, pp. 473-476 (V. 42)

Announcement and description only of a special book publication of the same title.

MAINTENANCE AND REPAIR OF PORTLAND CEMENT CONCRETE PAVEMENT 42-17

A. A. ANDERSON — Apr. 1946, pp. 477-492 (V. 42)

Highway maintenance consists of routine maintenance which is carried on daily and special maintenance conducted by appropriate intervals with specially trained crews — the better the routine maintenance, the less generally, the special maintenance.

Routine maintenance operations consist largely of sealing cracks and joints against infiltration of dirt and water and maintaining that seal. Operations vary with types of joints and climatic and subgrade conditions. Maintenance procedure for expansion joints filled with nonextruding and extruding material, contraction joints, construction joints and cracks, is described.

Items of special maintenance are covered in considerable detail as they generally require more engineering supervision.

Patching concrete pavements with concrete is best because, when properly done, patches are integral with the pavement and not inferior to the original slab. Procedure and methods of construction, based on extensive experience records, are discussed under the headings: slab thickness, removal of old slab, preparation of subgrade, materials and proportion of concrete, finishing and curing.

"Mudjacking" and materials and mixtures for the slurries are outlined as a means of both raising settled slabs and minimizing and preventing damage from pumping slab ends.

Methods and means of protecting existing concrete pavements against surface scale where air-entraining portland cement was not used during construction are also outlined.

CURING CONCRETE WITH SEALING COMPOUNDS 42-18

R. F. BLANKS, H. S. MEISSNER, and L. H. TUTHILL — Apr. 1946, pp. 493-512 (V. 42)

Following a general discussion of the principles involved in the curing of concrete, methods are presented for the effective use of sealing compounds for this purpose. Included are data for evaluating concrete curing by membrane treatment, in terms of equivalent moist curing. The paper discusses preferred methods of curing by use of sealing compounds, and outlines a specification and acceptance test for their purchase.

RADIANT HEATING BY REINFORCED CONCRETE 42-19

JOHN R. NICHOLS — Apr. 1946, pp. 513-516 (V. 42)

The question is examined whether the embedment of warm water pipes in structural concrete for the purpose of "radiant heating" (or "panel heating" as it is sometimes called) would endanger the integrity of the concrete. Some evidence is adduced in support of the tentative view that with reasonable restrictions on the installation, the results would not be too bad.

THE EXPANSION TEST AS A MEASURE OF ALKALI-AGGREGATE REACTION.42-20

R. F. BLANKS and H. S. MEISSNER — Apr. 1946, pp. 517-540 (V. 42)

Following the discovery that some aggregates are acted on by cement of inordinate alkali content, it has become popular to make expansion measurements on specimens incorporating the offending materials, subjected to curing in closed, moisture-laden containers. From the inherent limitations of such a test and the variety of ways in which it has been conducted, there has accumulated much conflicting data, the differences of which are discussed and recommendations given for greater tolerance in the interpretation of results. A procedure is proposed for appraising the reactive potentiality of prospective aggregates.

CONCRETE AT ADVANCE BASES...42-21

I. S. RASMUSSON — Apr. 1946, pp. 541-552 (V. 42)

Most of the advance base concrete work of the U. S. Navy in the Pacific Islands was done with coral aggregate because it was usually the only aggregate available. Producing a concrete generally inferior to that made with crushed rock or sand and gravel aggregates, coral served its purpose admirably in the temporary construction required in advance base planning. With proper selection and grading some corals will yield concrete with strengths little below that made of sand and gravel or crushed rock.

ASPHALTIC OIL-LATEX JOINT-SEALING COMPOUND 42-22

BRYANT W. POCOCK — June 1946, pp. 565-580 (V. 42)

The development of asphaltic oil-latex compounds for use in sealing expansion joints in concrete pavements is discussed. Laboratory tests devised by the Michigan State Highway Department for evaluating these seals are described and results of field installations in Michigan are reported. Tentative Michigan specifications for this type of seal are given.

PETROGRAPHY OF CONCRETE AGGREGATE 42-23

ROGER RHOADES and R. C. MIELENZ — June 1946, pp. 581-600 (V. 42)

Serviceability of a concrete aggregate depends on the manner in which it joins with cement to determine the quality of concrete. Yet, standard acceptance tests do not measure properties which are directly responsible for performance of aggregates enclosed in concrete; new methods of aggregate investigation are needed. Experience shows that petrographic study can supply valuable information on a routine basis, and that, wherever possible, ordinary acceptance tests should be supplemented by examination by a petrographer familiar also with problems of concrete. The significant properties of aggregates are discussed, and methods of petrographic study of aggregates are described.

An extensive bibliography is appended and referenced in the text for the benefit of readers, especially petrographers, wishing to explore further the concepts treated only briefly in this paper.

ENTRAINED AIR IN CONCRETE 42-24

A SYMPOSIUM — June 1946, pp. 601-604 (V. 42)

Foreword to a group of 14 papers, as listed 42-25 to 42-38 on air entrainment as presented at the 42nd Annual ACI Convention, Buffalo, N. Y., Feb. 19, 1946.

ENTRAINED AIR — A FACTOR IN THE DESIGN OF CONCRETE MIXES.....42-25

W. A. CORDON — June 1946, pp. 605-620 (V. 42)

Concrete containing air-entraining agents are being extensively employed in present day construction, and as entrained air alters many of the basic properties of concrete mixes such as water requirement, sand requirement, workability, etc., a series of 102 trial mixes was made to establish procedures for designing and adjusting concrete mixes containing entrained air. Useful data have been established from this set of tests, which should facilitate the adjustment and design of air-entraining concrete and also establish a basis for further investigation.

RECENT EXPERIENCES WITH AIR-ENTRAINING PORTLAND CEMENT CONCRETE IN THE NORTHEASTERN STATES 42-26

L. E. ANDREWS — June 1946, pp. 621-624 (V. 42)

Describes preliminary studies and current practice in the northeastern states in the reduction of frost action on concrete paving and other projects (roads, streets, airport pavements and hangars, bridges, and

buildings); mix proportioning, methods of determining air content, and field control. Specifications tend to limit air content to 3 to 6 percent rather than fix amount of air-entraining agent used.

EXPERIENCES WITH AIR-ENTRAINING CEMENT IN CENTRAL MIXED CONCRETE 42-27

ALEXANDER FOSTER, Jr. — June 1946, pp. 625-628 (V. 42)

Reports studies by Warner Co. with central-mixed concrete using air-entraining cement over 2½-years. Following experimental work, more than 30,000 cu yd of air-entrained concrete, chiefly of low-slump, plastic mix were used for pavements and other highway work. Studies included effect of truck-mixer or agitator action, closed drum and open top equipment, on hauls up to 45 min. No significant differences in slump or air entrainment (2½ to 3 percent) were found. The chief problem is in added storage requirements to meet specifications permitting no admixtures and those demanding air entrainment.

STUDIES OF CONCRETE CONTAINING ENTRAINED AIR 42-28

STANTON WALKER and DELMAR L. BLOEM — June 1946, pp. 629-640 (V. 42)

Problems of air entrainment in concrete have been particularly interesting to the ready-mixed concrete industry which has to meet a wide variety of specification requirements. This prompted exploratory studies in the Research Laboratory of the National Ready Mixed Concrete Assocation. Data are reported on effect of entrained air on compressive strength and mixing water requirements. Other factors considered are: mixing time, grading of aggregate, temperature, ratio of sodium hydroxide to Vinsol resin, comparisons of fresh and hardened concrete, and air content at different depths of concrete.

HOMOGENEITY OF AIR-ENTRAINING CONCRETE 42-29

HENRY L. KENNEDY — June 1946, pp. 641-644 (V. 42)

Reports studies of the homogeneity of air-entraining concrete by means of a test for resistance to abrasion. An air-entraining agent was used with no added accelerators, dispersing agents or gas forming materials. "Since air entrainment has a tendency to eliminate bleeding of concrete it is only reasonable to believe that such concretes are more homogeneous ....the top surface (of a slab) would have the same strength and density characteristics as the bottom surface." Plotted data show that there is progressive increase in abrasion loss in specimens as air content increases beyond 6 percent.

METHODS OF ENTRAINING AIR IN CONCRETE 42-30

E. W. SCRIPTURE, Jr. — June 1946, pp. 645-648 (V. 42)

Discusses methods for and mechanisms of air entrainment in concrete mixes. Methods include use of aluminum and hydrogen peroxide for entrainment of hydrogen or oxygen, respectively; use of cement dispersing agents; perhaps protective colloids. Date are reported to record the relation of air content to durability as determined by freezing and thawing.

EFFECT OF AIR ENTRAINMENT ON STONE SAND CONCRETE 42-31

A. T. GOLDBECK — June 1946, pp. 649-656 (V. 42)

A limestone sand which had been used with indifferent success in pavements and other structures, prompted a series of tests by National Crushed Stone Association, to improve workability and durability of concrete in which this aggregate was used. Results with and without Vinsol resin as an air-entraining agent were favorable to the use of the admixture. Data reported include materials, mix-proportioning, freezing and thawing tests.

A METHOD FOR DIRECT MEASUREMENT OF ENTRAINED AIR IN CONCRETE..42-32

W. H. KLEIN and STANTON WALKER — June 1946, pp. 657-668 (V. 42)

Since the amount of air entrained in concrete is of major importance and the methods now in use to determine that amount have inherent objections, the pressure method, by application of Boyle's law, has advantages. The Klein air meter is described, following tests by Pennsylvania-Dixie Cement Corp. and National Ready Mixed Concrete Association. The paper presents a description, with illustrations, of the Klein air meter, the test procedure, calculation of air content and calibration of meter, and presentation of data on the use of the method.

AUTOMATIC DISPENSING EQUIPMENT FOR AIR-ENTRAINING AGENTS 42-33

R. R. KAUFMAN — June 1946, pp. 669-672 (V. 42)

Automatic dispensing equipment is described as a means of getting an admixture into the concrete mix, at the mixer, with all the accuracy desirable.

MECHANICAL DISPENSING DEVICES FOR AIR-ENTRAINING AGENTS 42-34

E. M. BRICKETT — June 1946, pp. 673-676 (V. 42)

Several devices for accurate measurement of liquid admixtures as introduced into the concrete batch at the mixer are described and illustrated, with special reference to air-entraining agents as used in ready-mixed and concrete products plants, and on paving jobs. Since the quantity of the solution is relatively small, accuracy is important for uniform results.

A SIMPLE ACCURATE METHOD FOR DETERMINING ENTRAINED AIR IN FRESH CONCRETE 42-35

S. W. BENHAM — June 1946, pp. 677-680 (V. 42)

A short paper with subject matter as described in the title.

EFFECT OF USE OF BLENDED CEMENTS AND VINSOL RESIN-TREATED CEMENTS ON DURABILITY OF CONCRETE....42-36

W. F. KELLERMANN — June 1946, pp. 681-688 (V. 42)

Presents a part of the results obtained from an investigation of the durability of concrete, by the Public Roads Administration using blends of portland cements with natural cements (86 percent and 14 percent by weight, respectively) and Vinsol resin-treated cements. Results presented in this contribution have a bearing on resistance to freezing and thawing tests, especially because of unusual results of a prolonged interruption of the daily freezing and thawing cycle.

AIR-ENTRAINING CONCRETE — PENNSYLVANIA DEPARTMENT OF HIGHWAYS 42-37

W. H. HERMAN — June 1946, pp. 689-696 (V. 42)

The experiences of the Pennsylvania Department of Highways with air-entrained concrete, in which 331,555 bbl of normal strength portland cement containing Vinsol resin were used since 1940, are reported. The Pennsylvania department's attitude on the subject of air entrainment is characterized by more concern with the particular admixture used than with the percentage of air entrainment and such use was inspired by difficulties with finer ground cements which prompted seeking an additive to improve pavement durability.

PORTLAND-ROSENDALE CEMENT BLENDS GIVE HIGH FROST RESISTANCE 42-38

B. H. WAIT — June 1946, pp. 697-700 (V. 42)

Results are reported on numerous paving jobs in northeastern states, in the support of the use of portland cement blends as a means of reducing disintegration from frost action where the air entrained

averaged about 1 percent only. Results were satisfactory and the weight of the concrete was higher than for straight portland-Vinsol resin mixes.

THE REPAIR OF CONCRETE: AN INTRODUCTION 42-39

RODERICK B. YOUNG — June 1946, pp. 701-708 (V. 42)

The repair of concrete structures is an engineering problem, each job containing the elements of diagnosis, treatment, and execution. Diagnosis is essential to devising successful repair. Treatment may mean the correction of faults of design, materials, workmanship; protection against destructive agents and exposure; restoraton of decay; or a combination of these. The execution of repair may sometimes use methods of expediency rather than logic — a compromise between what one would like and what one can do. The paper considers the more common agents destructive to concrete and is a brief introduction to an important subject.

BEHAVIOR OF CONCRETE STRUCTURES UNDER ATOMIC BOMBING 42-40

E. H. PRAEGER — June 1946, pp. 709-720 (V. 42)

The destruction wrought by atomic bombing of the Japanese cities, Hiroshima and Nagasaki, August, 1945, is outlined, with an analysis of typical damage within areas with respect to "zero point." The survival of certain modern buildings of reinforced concrete and composite construction is noted with interest. The paper discusses principles and procedures of design necessary to resist attacks by these special new weapons.

Proceedings V. 43

REINFORCED CONCRETE COLUMNS UNDER COMBINED COMPRESSION AND BENDING 43-1

HAROLD E. WESSMAN — Sept. 1946, pp. 1-8 (V. 43)

Algebraic methods available heretofore for the analysis of the reinforced concrete column subject to combined compression and bending have usually involved the solution of a complex cubic equation and have taken considerable time when applied to particular problems. A new method of successive approximations converging rapidly to an exact answer and avoiding the use of the cubic equation is presented in this paper. The key to the method is the reciprocal relationship existing between the load axis and the neutral axis of the transformed section. The method may be applied to any shape of cross section and any arrangement of reinforcing steel, providing there is one axis of symmetry and the plane of bending coincides with this axis. The theory behind the method is presented and illustrated with three typical problems.

EFFECT OF MOISTURE ON THERMAL CONDUCTIVITY OF LIMEROCK CONCRETE 43-2

MACK TYNER — Sept. 1946, pp. 9-20 (V. 43)

The coefficient of thermal conductivity, k, of limerock concrete is a function of temperature, composition and density of moisture content. No attempt has been made to measure the effect of temperature on k. Holding the temperature reasonably constant, the effect of composition on k has been measured for two limerock concrete mixes (1:5 and 1:7 by volume). The 1:5 mix has a k that is 10 percent larger than the k for the 1:7 mix.

With the temperature and composition held constant, the effect of moisture on k for the 1:5 and 1:7 mixes has been measured. The moisture content has a profound effect on k, e.g., increases of moisture from 0 to 5 percent increases the k of 1:5 mix by 23 percent and from 0 to 10 percent increases the k by 46 percent. Concretes should be kept dry if their maximum heat insulation effect is desired.

CEMENT INVESTIGATIONS FOR BOULDER DAM — RESULTS OF TESTS ON MORTARS UP TO AGE OF 10 YEARS 43-3

RAYMOND E. DAVIS, WILSON C. HANNA, and ELWOOD H. BROWN — Sept. 1946, pp. 21-48 (V. 43)

The effects of composition and fineness of the laboratory cements employed in cement investigations for Boulder Dam on strength, volume changes, and sulfate resistance of mortars, are reported for ages up to 10 years. For both wet and dry storage conditions, factors for each of several ages are given which indicate the contribution of each of the four major compounds present in portland cement to tensile and compressive strengths and volume changes.

Errata — Part 2, Dec. 1947.

ANALYSIS AND DESIGN OF ELEMENTARY PRESTRESSED CONCRETE MEMBERS 43-4

HERMAN SCHORER — Sept. 1946, pp. 49-88 (V. 43)

The purpose of this paper is to outline the analysis and design of elementary prestressed concrete members, such as beams, columns, ties, etc., subjected to internal and external axial forces and bending moments. The internal stresses, caused by the action of the prestress forces, are combined with the stresses due to external loads in three typical loading stages. The first stage considers the stress condition resulting from the simultaneous application of all sustained loads. The second stage determines the stress changes due to normal live loads, based on a truly monolithic participation of the entire concrete area. The third stage assumes a cracked tension zone, which condition introduces the derivation of ultimate stresses and clarifies the influence of the prestress action on the type of failure. The analytical expressions are simplified by convenient ratios, which essentially define the sectional shape, the effective steel prestress, and the concrete fiber stresses. Numerical examples serve to illustrate the various steps.

STUDIES OF THE PHYSICAL PROPERTIES OF HARDENED PORTLAND CEMENT PASTE ....43-5a — 43-5g

T. C. POWERS and T. L. BROWNYARD — Oct. 1946, pp. 101-132, Nov. 1946, pp. 249-336, Dec. 1946, pp. 469-504, Jan. 1947, pp. 549-604, Feb. 1947, pp. 669-712, Mar. 1947, pp. 845-880, Apr. 1947, pp. 933-992 (V. 43)

IN NINE PARTS

Part 1. A Review of Methods That Have Been Used for Studying the Physical Properties of Hardened Portland Cement Paste
Part 2. Studies of Water Fixation
Appendix to Part 2
Part 3. Theoretical Interpretation of Adsorption Data
Part 4. Thermodynamics of adsorption
Appendix to Parts 3 and 4
Part 5. Studies of the Hardened Paste by Means of Specific-Volume Measurements
Part 6. Relation of Physical Characteristics of the Paste to Compressive Strength
Part 7. Permeability and Absorptivity
Part 8. The Freezing of Water in Hardened Portland Cement Paste
Part 9. General Summary of Findings on the Properties of Hardened Portland Cement Paste

This paper deals mainly with data on water fixation in hardened portland cement paste, the properties of evaporable water, the density of the solid substance, and the porosity of the paste as a whole. The studies of the evaporable water include water-vapor-adsorption characteristics and the thermodynamics of adsorption. The discussions include the following topics:

1. Theoretical interpretation of adsorption data
2. The specific surface of hardened portland cement paste.
3. Minimum porosity of hardened paste
4. Relative amounts of gel-water and capillary water
5. The thermodynamics of adsorption

6. The energy of binding of water in hardened paste
7. Swelling pressure
8. Mechanism of shrinking and swelling
9. Capillary-flow and moisture diffusion
10. Estimation of absolute volume of solid phase in hardened paste
11. Specific volumes of evaporable and nonevaporable water
12. Computation of volume of solid phase in hardened paste
13. Limit of hydration of portland cement
14. Relation of physical characteristics of paste to compressive strength
15. Permeability and absorptivity
16. Freezing of water in hardened portland cement paste

MINIMUM STANDARD REQUIREMENTS FOR PRECAST CONCRETE FLOOR UNITS 43-6

COMMITTEE 711 — Oct. 1946, pp. 133-148 (V. 43)
Supersedes 40-17, 42-11
Superseded by 50-1

These minimum standard requirements are to be used as supplements to the ACI "Building Regulations for Reinforced Concrete (ACI 318-41)." With respect to design for strength, i.e., for bending moment, bond and shear stresses, all types shall be designed in accord with standard reinforced design theory and ACI 318-41. With respect to cover, there is in some cases departure therefrom justified by the greater refinement in the finished product when made by factory methods with factory control. Precast floor systems with I-beam type and hollow core type joists are covered. Appendix contains applicable sections of the ACI code (ACI 318-41).

RECOMMENDED PRACTICE FOR THE CONSTRUCTION OF CONCRETE FARM SILOS 43-7

COMMITTEE 714 — Oct. 1946, pp. 149-164 (V. 43)
Supersedes 40-10, 42-12

These recommendations describe practice for use in the design and construction of concrete silos — stave, block, and monolithic, for the storage of grass or corn silage.

THE DURABILITY OF CONCRETE IN SERVICE 43-8

F. H. JACKSON — Oct. 1946, pp. 165-180 (V. 43)

Discusses the problem of concrete durability with reference primarily to highway bridge structures located in regions subject to severe frost action. Four major types of deterioration are defined and illustrated and several specific matters which have bearing on the problem, including the effect of construction variables, modern versus old fashioned cements, air entrainment, and the so-called cement-alkali aggregate reaction, are discussed. The report concludes with a series of recommendations indicating corrective measures which should be taken.

WEAR RESISTANCE TESTS ON CONCRETE FLOORS AND METHODS OF DUST PREVENTION 43-9

GEORG WASTLUND and ANDERS ERIKSSON — Oct. 1946, pp. 181-200 (V. 43)

Presents a description of tests made on concrete floor specimens of various types to determine their resistance to wear and to investigate the character of deterioration of concrete floor surfaces due to traffic. The results of these tests show that concrete floors provided with finish courses containing coarse aggregate up to about 1/3 in. in size and an excess of pea gravel are definitely superior to concrete floors with a finish course containing fine sand only which are common in Sweden. Moreover, this investigation has helped to elucidate the causes of the often severe and detrimental dusting of concrete floors. The surface skin of concrete floors is of poor quality and is easily abraded. Dusting can be considerably reduced if the poor surface skin is removed by machine grinding provided that the concrete below the surface skin is of first-rate quality. The paper concludes by proposing a detailed tentative specification for concrete floor finish which differs in essentials from current Swedish practice.

LINING OF THE ALVA B. ADAMS TUNNEL 43-10

RICHARD J. WILLSON — Nov. 1946, pp. 209-240 (V. 43)

The 13.03 mile Alva B. Adams Tunnel, excavated under the Continental Divide, as a part of the transmountain water diversion plan of the Colorado-Big Thompson Project, United States Department of the Interior, Bureau of Reclamation, is lined with concrete. Lining equipment and methods and aggregate processing are described.

REPAIRS TO SPRUCE STREET BRIDGE, SCRANTON, PENNA. 43-11

A. BURTON COHEN — Nov. 1946, pp. 241-248 (V. 43)

Repairs and reinforcements of the Spruce Street Bridge built in 1893 over the Lackawanna Railroad and Roaring Brook in Scranton, Pa., are described. The effective application of the "Alpha System-Composite Floor Design" reinforced the floor system at the same time a new concrete floor slab was laid. Concrete prices are included.

THE STRUCTURAL EFFECTIVENESS OF PROTECTIVE SHELLS ON REINFORCED CONCRETE COLUMNS 43-12

F. E. RICHART — Dec. 1946, pp. 353-364 (V. 43)

Presents a study of 108 plain, tied, or spirally reinforced concrete columns. The columns were 7, 8, and 9 in. round or square, 45 in. long, and the ties and spirals were 6 in. in diameter.

The columns were loaded axially, with "flat" ends. Strains were measured and close observations were made of the initial failure of the protective shell.

Analyses of the test results were made to see if the column shells were fully effective. This was the case with the shells of spirally reinforced columns, but the tied columns showed a slight deficiency in the strength expected on the basis of previous tests of the 1930 ACI column investigation.

The test results lend support to the design methods prescribed in the current ACI Building Regulations for Reinforced Concrete.

PRECAST CONCRETE STRUCTURES . . 43-13

A. AMIRIKIAN — Dec. 1946, pp. 365-380 (V. 43)

Precasting is becoming a major factor in the choice of reinforced concrete as a construction material because of ever-rising cost of labor and materials. The advantages of precasting are not however confined to savings in cost and materials. Since it is a planned method of construction, comparable to factory production, its use also assures a better control of quality and speedier completion of the project. This article is an attempt to show how precasting can be utilized to provide the framing of a great variety of structures. The first part deals with bent type of framing as used in buildings, the second describes a novel type of framing consisting of precast cells, particularly suitable for floating structures.

COMPARATIVE BOND EFFICIENCY OF DEFORMED CONCRETE REINFORCING BARS 43-14

ARTHUR P. CLARK — Dec. 1946, pp. 381-400 (V. 43)

The purpose of the tests described was to determine the resistance to slip in concrete of 17 different designs of deformed reinforcing bars.

The tests were of the pull-out type in which the bars were cast in a horizontal position; the depth of concrete under the bars and the length of embedment were varied. The slip of the bar was measured at the loaded and free end. Three tests were made of each variable for each design of deformation.

It was established that a certain group of the bars was definitely superior to the others, in the sense that their average rating was significantly higher

than the average of the others. Bars cast in the top position were much less effective than those cast in the bottom position.

PROPOSED REVISION OF BUILDING REGULATIONS FOR REINFORCED CONCRETE (ACI 318-41) 43-15

COMMITTEE 318 — Dec. 1946, pp. 401-468 (V. 43)

Superseded by 44-1

The report with its proposed changes has been released by the Standards Committee for convention action.

The contents are fully explained in the title. The current "code" appears in full in larger type, the proposed changes in smaller type. Published for information and study prior to convention consideration.

HIPPED PLATE CONSTRUCTION 43-16

GEORGE WINTER and MINGLUNG PEI — Jan. 1947, pp. 505-532 (V. 43)

Discusses and illustrates a method of design and construction increasingly used in Europe since the early thirties, but hardly known in this country. Named "Faltwerke" abroad, such structures consist of rigid reinforced concrete boxes made up of slabs joining at various angles, without the aid of beams or girders. In view of the considerable rigidity of the box as a whole, such structures can be made to bridge considerable spans without intermediate supports in the form of columns, frames, or trusses. The type of construction is particularly applicable to bunkers, long span roofs, hangars, and the like.

Paper is essentially a digest of the extensive European literature on the subject. It aims to discuss the essential design procedures, though not pretending to be complete with regard to questions of somewhat secondary importance. Originality is only claimed in the development of an appropriate, simplifying distribution method, the introduction of a consistent sign convention, and other substantial, practical simplifications.

Examples of erected structures are illustrated, a design example is given, and an extensive foreign bibliography is appended.

HYDRAULIC STRUCTURE MAINTENANCE USING PNEUMATICALLY PLACED MORTAR 43-17

W. L. CHADWICK — Jan. 1947, pp. 533-548 (V. 43)

Where exposed to frequent freezing and thawing cycles while saturated, concrete in hydraulic structures and on snow-covered flat or nearly flat surfaces suffers deterioration which requires repair before the strength of the affected structure is seriously impaired. The principal causes of deterioration are enumerated, and several methods of customary repair are discussed, with special mention of the methods employed in making repairs to a number of hydraulic conduits and dams in the high Sierras of California.

MR. CHAIRMAN 43-18

R. W. CRUM — Feb. 1947, pp. 613-616 (V. 43)

The author "has fun" over the performance of chairmen in the conduct of technical meetings as he did on another occasion, with the authors' presentations of their papers, in "Technical Tedium or Otherwise."

OBSERVATIONS OF WAR DAMAGE TO CONCRETE AND TO CEMENT INDUSTRY PROPERTIES IN GERMANY 43-19

MYRON A. SWAYZE — Feb. 1947, pp. 617-628 (V. 43)

While on a 7 week trip through Germany making a survey of the German cement industry, the author observed damage to structures resulting from allied bombing. Types of German cement are compared with American cement and though German cements were generally considered as inferior to American, their high quality of concrete presented a paradox as seen in the durability of their roads. Illustrations show results of bombing on hotels, bridges, cement and industrial plants, and dams. An interesting example of the use of a mound of gravel as formwork for an arch factory roof is described. The author believes American engineers could profit by a study of German examples of precast concrete.

CRACKS IN CONCRETE 43-20

BYRAM W. STEELE — Feb. 1947, pp. 629-636 (V. 43)

Cracks in concrete that are irregular and uncontrolled are objectionable. If causes were better understood, the elimination of cracks would be less difficult. Cracks are mainly due to one or more of the following causes: (1) lack of adequate investigation of all the ingredients involved; (2) lack of sufficient advance planning to obtain satisfactory results; (3) lack of team work in the human element involved in this intricate manufacturing process; and (4) lack of teamwork (compatibility) in the ingredients which include alkali-aggregate reaction and the use of argillaceous limestone and chert as aggregate. The modern laboratory's test procedure will not condemn many limestones and cherts that are capable of starting surface cracking. The elimination of unsound types is not at all a simple procedure. A suggested A-B-C procedure is offered toward the partial elimination of cracks: A. to establish approved sources of aggregate with good service record; B. thoroughly investigate new sources of supply subjecting them to all known tests including analysis by a petrographer; C. study the design of every structure proposed with a view towards eliminating structural cracks by proper control of the design of the mix and the placing of the concrete and provide relief from volume change tensile stresses, with designed cracks placed where they will not be objectionable.

CONTRACTION JOINT GROUTING OF LARGE DAMS 43-21

A. WARREN SIMONDS—Feb. 1947, pp. 637-652 (V. 43)

The practice of the United States Bureau of Reclamation is to build large dams in blocks bounded by keyed joints to minimize cracking caused by shrinkage which is due to dissipation of the setting heat of the concrete. After the concrete reaches its minimum temperature the voids in the joints between the blocks are filled with cement grout under pressure to create a concrete monolith. This paper describes experiences in the development of the present grouting techniques and the actual process of grouting contraction joints in large concrete dams. Special reference is made to grouting at Shasta Dam.

REPAIR OF CONCRETE CHIMNEYS WITH A MINIMUM OF INTERFERENCE WITH OPERATION OF BOILERS 43-22

W. M. BASSETT and M. N. CLAIR — Feb. 1947, pp. 653-668 (V. 43)

Demolition of a concrete chimney at public utility plant provided an opportunity to study the relation of SO_3 content of the cross section of the shell to the condition of the concrete. This data used to supplement physical examination in determining necessity for repair of two other chimneys at same plant. Wartime conditions required repair without plant shutdown. Methods employed and results obtained are described in detail.

SOME PROBLEMS IN STRUCTURAL FRAMING OF PRECAST CONCRETE HOUSES 43-23

A. AMIRIKIAN — Mar. 1947, pp. 797-812 (V. 43)

The use of precast concrete elements in large-scale housing projects places special emphasis on the importance of the structural framing. To take full advantage of benefits inherent in the precast technique, it is necessary that the design of the framing be given the same care as that generally accorded to the structural analysis and design of any large and important structure. To this end, criteria of design and the arrangement of framing are predicated on theoretical as well as on practical considerations, to assure adequacy of strength, adaptability to mass production and economy of construction. Some of the problems encountered in the design of the fram-

ing are discussed in this paper, and the application of the basic principles is illustrated by two examples outlining the arrangement and details of framing of two types of low-cost dwellings.

THE MAINTENANCE AND RECONSTRUCTION OF CONCRETE TUNNEL LININGS WITH TREATED MORTAR AND SPECIAL CONCRETE . . 43-24

B. D. KEATTS — Mar. 1947, pp. 813-828 (V. 43)

Defects in concrete tunnel linings such as disintegration, seepage, honeycomb, cracking, and structural failures and faulty conditions in earth and rock formations through which tunnels have been bored have been corrected with treated mortars, a special concrete and through unconventional methods of applying them.

Paper includes a general discussion of tunnel maintenance problems, a description of the mortar, concrete, and methods employed in the repairs of four selected tunnels.

CONCRETE MIX DESIGN — A MODIFICATION OF THE FINENESS MODULUS METHOD 43-25

MYRON A. SWAYZE and ERNST GRUENWALD — Mar. 1947, pp. 829-844 (V. 43)

A comparison of three maximum size gradings of sand-gravel and sand-crushed stone mixtures in concrete has revealed that for each type and size of coarse aggregate a constant value for fineness modulus will be obtained for any workable mixture from lean to rich, if the cement is included in the modulus figures. While trial batches are still recommended for previously unused aggregates the modification proposed for the old fineness modulus method permits the design of equally workable batches of varied cement contents from data on trial mixes of a single cement factor. This materially reduces the number of test batches where a range of cement contents is to be used with a set of aggregates.

The method described for calculation of batches compensates for differences in specific gravity of fine and coarse aggregates.

THE INSTITUTE — TODAY AND TOMORROW 43-26

HARRISON F. GONNERMAN—Apr. 1947, pp. 885-892 (V. 43)

The address of the retiring President at the 43rd annual convention in Cincinnati summarizes the activities and progress made by the Institute during the preceding year and outlines the plans conceived during the year for the future. The author objectively reveals the prospects for future growth of the Institute.

OIL WELL CEMENTING PRACTICE . . 43-27

R. E. MOELLER and HAYDEN ROBERTS — Apr. 1947, pp. 893-912 (V. 43)

Oil well cementing is a highly specialized service; special procedures and equipment are necessary to accomplish the desired results. Wells are cemented to eliminate contamination, to repair leaks in pipe, to reduce the depth of the hole and to correct various well conditions when necessary. Paper outlines the different procedures and describes some of the equipment used.

Some of the more fundamental problems encountered in well completions are mentioned and the methods used to correct problems are briefly described.

PAINTING INTERIOR CONCRETE SURFACES: THE EXPERIENCE OF ONE ORGANIZATION 43-28

T. H. CHISHOLM — Apr. 1947, pp. 913-916 (V. 43)

Twenty-five years' experience in painting the interior of concrete buildings has demonstrated that if a few simple precautions are taken, it offers no more difficulty than does the painting of wood or other materials. Paper describes the practices of the Hydro-Electric Power Commission of Ontario which have prompted this conclusion.

NOTES ON THE THEORY AND PRACTICE OF FOUNDATION GROUTING 43-29

V. L. MINEAR — Apr. 1947, pp. 917-932 (V. 43)

Foundation grouting presents one of the most controversial problems in dam design and construction. Successful treatment of any given foundation requires modification in standard technique to meet existing conditions. Methods used successfully on one job may not always be satisfactory on another. Paper presents and discusses certain theories and practices in this important and costly phase of dam construction.

A STUDY OF THE INFLUENCE OF THERMAL PROPERTIES ON THE DURABILITY OF CONCRETE 43-30

ALBERT WEINER — May 1947, pp. 997-1008 (V. 43)

An attempt is made to rationalize the effect of air content and type of aggregate on the durability of concrete by a consideration of the thermal properties. The principal thermal properties of plain, Vinsol resin, and neutralized Vinsol resin concrete made with siliceous gravel and with trap-rock under two mixing conditions (air and vacuum-mix) are presented. The increased durability developed by addition of an air-entraining admixture does not appear to be a result of the slight change in thermal properties accompanying air entrainment. When differences in thermal diffusivity exist between mortar and coarse aggregate, rapid freezing and thawing may cause failure by internal expansion. This paper should be considered as a progress report on the subject and the conclusion set forth as tentative, subject to verification by the results of further study.

EROSION OF CONCRETE BY CAVITATION AND SOLIDS IN FLOWING WATER 43-31

WALTER H. PRICE — May 1947, pp. 1009-1024 (V. 43)

High velocity water jet and shot-blast tests which were made to determine the effects of mix proportions, curing, absorptive form lining, air entrainment, and surface finish on the erosion resistance of concrete are described. Examples of erosion failures in hydraulic structures by wear and cavitation and methods of repair are included.

THE CAMERA LUCIDA METHOD FOR MEASURING AIR VOIDS IN HARDENED CONCRETE 43-32

GEORGE J. VERBECK — May 1947, pp. 1025-1040 (V. 43)

The camera lucida method for the determination of the air content and the air void characteristics of hardened cement pastes, mortars, and concretes is described. Data are included to demonstrate the influence of experimental factors on the results obtained by the camera lucida method.

A comparison is made of the void concentrations and average void areas of the air entrained by different types of agents and under different mixing conditions. No factors significantly altering the void characteristics in concrete are revealed in the tests thus far made. The air contents of hardened concretes as determined by the camera lucida method compare satisfactorily with results obtained by other methods applied to the same concretes when in the plastic state.

DISTRIBUTION OF BOND STRESS IN CONCRETE PULL-OUT SPECIMENS . . 43-33

DAVID WATSTEIN — May 1947, pp. 1041-1052 (V. 43)

The purpose of this investigation was to determine the effect of length of embedment and the kind of deformation pattern of the reinforcement bar on the distribution of bond stress in pull-out specimens. Twenty-five specimens 6-in. in diameter by 8-in. long and 25 specimens 6-in. in diameter by 12-in. long,

containing ¾-in. diameter round bars of five different types were tested.

The bond stresses in the 8-in. specimens were considerably more uniform along the length of the bar than were those in the 12-in. specimens.

Bond stresses increased most rapidly with slip at the loaded end of the bars, and in general, least rapidly at the free end. This divergence of the values of bond stresses for a given slip was more pronounced for the longer lengths of embedment.

DEVELOPMENT AND STUDY OF APPARATUS AND METHODS FOR THE DETERMINATION OF THE AIR CONTENT OF FRESH CONCRETE....43-34

CARL A. MENZEL — May 1947, pp. 1053-1072 (V. 43)

Describes new apparatus and methods developed for the determination of the entrained air content of fresh concrete. The test methods developed are based on two different principles, neither of which requires weighing scales: (1) Direct Volumetric Method in which the volume of air removed from a sample of fresh concrete inundated in an approximately equal volume of water is indicated directly by the volume of liquid required to restore the original liquid level after the removal of the entrained air; (2) Pressure Method (proposed by Klein and Walker) in which the volume of air entrained in a sample of fresh concrete is indicated by the change in volume of the concrete when a known pressure is applied to the sample.

Extensive tests show good correlation between the "Rolling Method" (a direct volumetric method in which air is removed by rolling the concrete in an excess of water) and the "Pressure Method" for concrete mixes representing a wide range in cement content, consistency, natural coarse aggregate, and method of incorporating the air-entraining agent. Good correlation has also been obtained in tests conducted at four temperatures (44, 62, 79, and 100 F).

Both laboratory and field experience with different methods indicate that, all things considered, the pressure method is probably the most practical for field tests. The rolling and modified rolling methods, although equal in dependability to the pressure method, appear to rank second to it in practicability. These studies provided a basis for the design of suitable apparatus for testing 0.22 cu ft concrete samples (with 2-in. maximum size aggregate) by the pressure and rolling methods.

PAINTING EXTERIOR CONCRETE SURFACES WITH SPECIAL REFERENCE TO PRETREATMENT 43-35

G. E. BURNETT and A. L. FOWLER — June 1947, pp. 1077-1088 (V. 43)

Laboratory evidence is presented to demonstrate that pretreatment is invaluable if not essential to the successful use of oil-base paints on concrete surfaces. An effective pretreatment is described as consisting of a water solution of 2 percent zinc chloride — 3 percent phosphoric acid. With proper pretreatment, it is indicated that paint on concrete may last longer than paint on wood and that the customary extended aging period for concrete prior to painting may be omitted.

SOME OBSERVATIONS ON USING THEORETICAL RESEARCH 43-36

T. C. POWERS — June 1947, pp. 1089-1096 (V. 43)

Theoretical papers have immediate practical value if they are studied so as to become a part of one's working knowledge. Such papers seldom give direct answers to specific questions, but answers to various questions may emerge from detailed consideration of a specific phenomenon. For example, the volume contraction accompanying hydration, considered along with data on the characteristics and behavior of evaporable water in cement paste, gives useful information pertaining to curing methods and concrete durability.

PRECAST CONCRETE STOREHOUSES.43-37

ARSHAM AMIRIKIAN — June 1947, pp. 1097-1116 (V. 43)

The two concrete storehouses at Mechanicsburg, Pa., popularly known as the Navy's "precast warehouses," are the first structures built entirely of prefabricated concrete elements, utilizing the thin-shell technique. The framing consists of a series of bents and the surmounting system of ribbed roof panels. The component members of the bents are of hollow cross section. The hollow segments, which characterize the main framing, are obtained by bolting together matching pairs of thin-walled channel-shaped elements. To provide continuity at the joints, the reinforcing bars of adjacent segments are welded in the splice gaps and the joint pockets filled with grout. Paper describes the basic features of design, fabrication and erection of the framing.

PRECAST CONCRETE WAREHOUSE CONSTRUCTION 43-38

LOUIS P. CORBETTA — June 1947, pp. 1117-1124 (V. 43)

The contractor, who built two experimental warehouses of thin shell precast concrete elements for the United States Navy under a lump sum contract awarded on a competitive basis, describes how the unique construction problems involved were approached and solved. Also discussed are the actual costs of the job and the estimated costs of building five similar warehouses with the "know-how" gained on the first two.

BOND CHARACTERISTICS OF COMMERCIAL AND PREPARED REINFORCING BARS 43-39

S. T. COLLIER — June 1947, pp. 1125-1136 (V. 43)

A study of the bond resistance of deformed reinforcing bars as affected by type of deformation, position of anchorage, and the consistency of the concrete in which they were embedded. Forty-eight specimens representing five bar designs were made for pull-out tests, two tests for each set of conditions.

THE CORROSION OF REINFORCING STEEL IN CRACKED CONCRETE....43-40

BAILEY TREMPER — June 1947, pp. 1137-1144 (V. 43)

Sixty-four small concrete blocks containing steel wires and deformed bars as reinforcing were loaded as beams to produce cracks normal to the direction of the steel. After 10 years outside exposure, the steel specimens were removed from the concrete and examined for the amount of corrosion. Corrosion was found for short distances in the region of the cracks but was too minor in degree to be considered of serious consequence.

Proceedings V. 44

BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-47) 44-1

COMMITTEE 318 — Sept. 1947, pp. 1-64 (V. 44)

Superseded by 47-43
Supersedes 43-15

This code covers the proper design and construction of buildings of reinforced concrete. It is written in such a form that it may be incorporated verbatim or adopted by reference in a general building code, and earlier editions of it have been widely used in this manner.

Among the subjects covered are: quality of concrete, allowable stresses, mixing, placing, curing, and cold weather protection of concrete, forms, cleaning, bending, placing, splicing, and protection of reinforcement, construction joints, general design considerations, flexural computations, shear and diagonal tension, bond and anchorage, flat slabs, columns and walls, and footings.

The quality and testing of materials used in the construction are covered by references to the appropriate ASTM standard specifications.

THE FIVE-YEAR TEMPERATURE RECORD OF A THIN CONCRETE DAM....... 44-2

S. D. BURKS — Sept. 1947, pp. 65-76 (V. 44)

Temperature in concrete structures is of interest mainly because it is often a cause of cracking. When joints are provided in a structure, their behavior and the need for grouting are largely a question of temperature. Presented herein is the temperature history of a thin concrete dam, based on results of more than 5 years of observation. The temperature rise of concrete is given, as well as the effect of thickness of section on temperature behavior. Also shown are graphical trends of cooling, time lag of concrete temperature behind air temperature, typical surface and near-surface temperatures; annual concrete temperature variations are given, along with a discussion of orientation of structure and the consistent form of final temperature fluctuations.

CEMENT-AGGREGATE REACTION IN CONCRETE 44-3

DUNCAN McCONNELL, RICHARD C. MIELENZ, WILLIAM Y. HOLLAND, and KENNETH T. GREENE— Oct. 1947, pp. 93-128 (V. 44)

The chemical interaction of certain rocks and minerals of aggregate with high-alkali portland cements is known to have caused serious distress of concrete structures in California, Oregon, Idaho, Arizona, Nebraska, Kansas, Washington, Wyoming, Virginia, and New York. Similar distress will undoubtedly be discovered in other states. Microscopic, microchemical and physical-chemical studies of concrete have revealed the detailed characteristics of the deterioration, and make possible the distinction of this type of deterioration from others. Petrographic and physical-chemical investigations have identified the rocks and minerals which are susceptible to attack by cement alkalies.

The expansion and cracking of the concrete result from osmotic pressures developed in alkalic silica gels that are produced by partial dissolution of siliceous rock and mineral substances. Laboratory experiments and calculations indicate that these osmotic pressures exceed 550 psi.

CRACK CONTROL IN PORTLAND CEMENT PLASTER PANELS 44-4

BERT A. HALL — Oct. 1947, pp. 129-140 (V. 44)

Desirability of using portland cement plaster for surfaces exposed to water spray and condensation impelled Bureau of Reclamation studies of cause and control of its cracking. Tests indicated shrinkage to be the chief factor in cracking of portland cement plaster. Method of application described eliminates restraint at all edges of the plaster slab, allowing shrinkage to take place without stress development and the attendant cracking. Savings are effected by application of successive plaster coats at 24-hr intervals, damp-curing of individual coats is eliminated and the final curing period is shortened by careful control.

DETERIORATION OF CONCRETE IN BRINE STORAGE TANKS.......... 44-5

INGE LYSE — Oct. 1947, pp. 141-148 (V. 44)

A survey in Norway revealed serious deterioration of concrete storage tanks for low-temperature NaCl and $CaCl_2$ brine. Laboratory tests indicated deterioration was caused by low temperature rather than brine action alone. It is believed that the brine penetrates the concrete, producing a salt solution which varies from relatively high concentration at the surface to low concentration some distance within. Low brine temperature will produce freezing of the water of the concrete except where salt concentration is sufficient to prevent it. At a certain depth from the surface, salt concentration will be just sufficient to give an equilibrium between freezing and no freezing of the water. Here there will be a continual freezing and thawing action as the brine temperature changes a few degrees. Such action causes rapid disintegration. Suggested remedies are thorough drying to remove water near surface of concrete, and a seal coat to prevent brine penetration.

EFFECT OF GYPSUM CONTENT AND OTHER FACTORS ON SHRINKAGE OF CONCRETE PRISMS. 44-6

GERALD PICKETT — Oct. 1947, pp. 149-176 (V. 44)

The effects of gypsum content of cement and other factors on shrinkage and cracking tendency of concretes are investigated by methods described in a previous paper. An essential feature of the method is that prisms of the concretes are permitted to dry from only one side. It is found that there is in general an optimum gypsum content for each cement for minimum loss in weight, a different optimum for minimum shortening and still a different optimum for minimum warping. The data were too limited to indicate clearly whether or not there was also an optimum gypsum content for each cement for a maximum factor of safety against cracking. For the two cements of Type I used in this study the highest factors of safety were obtained with the highest gypsum contents used, indicating that the optimum was still higher. For the other cements there was no consistent indication that gypsum content had any effect on factor of safety. Specimens wet-cured 28 days shortened and warped less but developed higher shrinkage stresses than specimens wet-cured 7 days. There are indications that the rate of hydration during the first few hours has an effect on shrinkage during subsequent drying.

PROTECTION OF ELECTRIC STRAIN GAGES IN CONCRETE 44-7

R. H. SHERLOCK and ADIL BELGIN — Nov. 1947, pp. 189-192 (V. 44)

Writers describe a device for protecting an SR-4 electric strain gage from moisture and pressure while attached to a reinforcing bar embedded in concrete. The procedure and precautions to be observed in installing the gage and shield are outlined.

CHEMICAL TEST FOR REACTIVITY OF CONCRETE AGGREGATES WITH CEMENT ALKALIES, CHEMICAL PROCESSES IN CEMENT-AGGREGATE REACTION .. 44-8

RICHARD C. MIELENZ, KENNETH T. GREENE, and ELTON J. BENTON — Nov. 1947, pp. 193-224 (V. 44)

Potential deleterious reactivity of aggregates with high-alkali cements can be predicted from results of a newly developed chemical test. Determination of deleteriousness is based on the amount of silica dissolved by a 1N sodium hydroxide solution from a representative sample of the aggregate crushed to the No. 50 to No. 100 size, and the concomitant reduction effected in the alkalinity (potency) of the solution. The samples can be prepared, the test run and the necessary chemical analysis completed in 3 work days.

The test has indicated correctly the deleterious or innocuous character of approximately 70 sands, gravels, rocks and minerals for which mortar bar data and many service histories are available. The results of the test substantiate hypotheses developed to explain the phenomenon of the pessimum proportion and the rates of mortar expansion characteristically caused by deleterious aggregates of different types.

A specific test procedure is described and is recommended for inclusion in the program of tests ordinarily applied to determine quality of concrete aggregates.

ANALYSIS OF TWO-COLUMN SYMMETRICAL BENTS AND VIERENDEEL TRUSSES HAVING PARALLEL AND EQUAL CHORDS 44-9

JOHN E. GOLDBERG — Nov. 1947, pp. 225-236 (V. 44)

An analysis suitable for quick application to two-column symmetrical bents with vertical columns and Vierendeel trusses having parallel and similar chords is presented. Method is based on an equation expressing joint rotation in a given story as a function of shear in adjoining columns and of joint rotation

in the two adjacent stories. After joint rotations are determined, moments are calculated by simple, specialized slope deflection equations. Method may be directly applied for panel point loads; other loadings are resolved to equivalent panel point loads. Illustrated solutions are developed for a six-story bent and an unsymmetrically loaded Vierendeel truss.

PLASTIC FLOW OF THIN REINFORCED CONCRETE SLABS . . . 44-10

GEORGE W. WASHA — Nov. 1947, pp. 237-260 (V. 44)

Presents the results of tests on end-supported, reinforced concrete slabs. 3 x 12 in. cross section, which were subjected to sustained loads for 5 years. The variables included three concrete slumps, two water-cement ratios, three span lengths, and two curing methods. Total and plastic flow deflections, changes in the concrete compressive strains, and changes in the steel tensile strains were obtained. The importance of the plastic flow problem in thin reinforced concrete slabs is forcibly emphasized by the large increases in deflections and strains that were obtained over 5 years.

PRECASTING CONCRETE PIPE FOR THE SAN DIEGO AQUEDUCT 44-11

D. K. WOODIN — Dec. 1947, pp. 261-288 (V. 44)

Method of precasting high and low head concrete pipe, 48 to 96 in. in diameter, for the San Diego aqueduct is described in detail, profusely illustrated. Steel cylinder and cage type of reinforcement and a combination of the two are described. Cement composition and properties and mix proportions are tabulated; vibration methods, handling and storage difficulties, preparation of forms and reinforcement, placing of concrete and curing conditions are discussed. Emphasis is on the economy of correct vibration processes, and problems encountered in establishing them.

STRENGTH AND SLIP UNDER LOAD OF BENT-BAR ANCHORAGES AND STRAIGHT EMBEDMENTS IN HAYDITE CONCRETE 44-12

C. C. FISHBURN — Dec. 1947, pp. 289-308 (V. 44)

Steel bars, ½ in. in diameter, of three kinds, one plain and two deformed, were embedded in Haydite aggregate concrete. The load and slip at the pull-out ends were observed for bent and straight anchorages of each kind of bar. For like slips and equal embedded lengths, the straight embedments of the deformed bars were stronger than the plain bent-bar anchorages. Differences in the lug height and lug-bearing area of the two deformed bars affected the relative strength of anchorages containing these bars.

PROPOSED RECOMMENDED PRACTICE FOR WINTER CONCRETING METHODS 44-13

COMMITTEE 604 — Dec. 1947, pp. 309-328 (V. 44)

Superseded by 45-1

Proposes standard methods of cold-weather concreting for thin sections and mass concrete. Heating of materials, accelerators and anti-freezes, curing and temperature records during curing, subgrade (or base) preparation, protective coverings during curing, and form removal are discussed for both types of job, and preferred methods are indicated. An appendix entry outlines objectives of the special winter methods with background material which indicates the "why" of some of the recommended practices. Charts in the appendix indicate effect of curing temperature on concrete strength, and a list of 135 selected references to periodical literature on winter concreting methods is included.

SOME DOUBTS ABOUT CONCRETE . . 44-14

Jan. 1948, pp. 345-348 (V. 44)

A searchingly critical appraisal of progress in knowledge of concrete and of its application to practice appeared as an editorial in Engineering-News Record, Feb. 1, 1923, a few days after the Institute's 19th annual convention in Cincinnati that year. Coming to light recently in an ACI office scrapbook, it inspired a reappraisal of progress for ACI's 44th annual convention, Feb. 23-26, 1948. Through the courtesy of Engineering-News Record it is republished as the point of departure for a full session at the 1948 convention in Denver.

ECONOMY IN STRUCTURAL DESIGN 44-15

I. E. MORRIS — Jan. 1948, pp. 349-360 (V. 44)

High construction costs today challenge the engineer to produce sound money-saving designs without too rigid an adherence to conventional patterns. The value of good engineering judgment is emphasized. Slab band construction is suggested for cutting cost, since expensive beam forms may be eliminated, story heights are decreased and pipe and conduit installations are simplified. Ideal layouts and dimensions for slab band construction are noted, and design for shear resistance is considered. The author cites personal experience in the design of floor framing for a 12-story 500-bed hospital. Five different designs (all illustrated) were prepared and cost comparisons made. Of the five (slab band, dropped beam, conventional concrete beam and slab and two types of encased structural steel) the slab band system proved least expensive, with dropped beam construction a close second.

STUDY OF CAUSES AND PREVENTION OF STAINING AND POP-OUTS IN CINDER CONCRETE 44-16

S. G. SEATON — Jan. 1948, pp. 361-380 (V. 44)

Reports a study of cinder aggregates designed to determine the cause of strains and pop-outs in cinder concrete and to develop methods of cinder treatment to eliminate trouble from these sources. The causes are identified, a simple method is described for detecting the presence in cinders of the impurities causing stains and some classes of pop-outs, and at least two practicable methods are presented for cinder treatment. Correlation between laboratory tests and field performance of concrete masonry units is shown and a specification is suggested to minimize the occurrence of stains and pop-outs.

CONCRETE MAKING IN CHINA . . . 44-17

JOHN S. COTTON — Jan. 1948, pp. 381-400 (V. 44)

Mr. Cotton outlines the supply situation and production methods for concrete materials in China. Data are presented on type, quality and availability of cement, reinforcing steel and forms. Aggregate sources, handling methods and gradation are discussed. Data on concrete strengths, mixing and placing, labor problems, and costs are given. Concreting, mortar, masonry work, and design of the Lung Chi Ho hydro development are described. Design and history of the Sungari River hydro project are developed with attention to Japanese concreting methods. Hazardous condition of the dam is ascribed to faulty construction practices occasioned by pressure of the war. The emergency repair program of the National Hydroelectric Engineering Bureau of China is outlined, and current concreting practices of the bureau are discussed. Illustrations depict many of the almost primitive methods which must be employed.

DESIGN OF RECTANGULAR TIED COLUMNS SUBJECT TO BENDING WITH STEEL IN ALL FACES. 44-18

D. R. CERVIN — Jan. 1948, pp. 401-412 (V. 44)

One of the fastest accurate methods of designing rectangular tied columns, subject to compression and bending, is the procedure of converting the effect of bending to an equivalent axial load and proportioning the column to the requirements of the increased axial load. Present tabular data confine this procedure to steel in the end faces only. A method is proposed in this paper which permits a rapid design for steel in all faces for any rectangualr section.

PREVENTION OF DAMPNESS IN BASEMENTS 44-19

CYRUS C. FISHBURN — Feb. 1948, pp. 421-436 (V. 44)

The selection of appropriate measures for a dry basement depends on a consideration of the external conditions at the site. Basements may be located in well-drained or in saturated soil and meteorological conditions may be conducive to condensation within them.

The drainage of surface and subsurface water away from a basement is important where this is possible. Methods of constructing the walls and floors of new basements to prevent seepage and condensation are described. Simple tests for determining the causes of dampness in existing basements are given and remedial treatments against dampness in them are outlined.

HIGHLIGHTS OF THE DEVELOPMENT OF REINFORCED CONCRETE AND THE STUDY OF BOND.............44-20

ARTHUR P. CLARK — Feb. 1948, pp. 437-440 (V. 44)

This paper is introduced by a brief history of the development of concrete and reinforced concrete since portland cement was first made about 125 years ago. The French are credited with the first use of reinforcement a little after the middle of the 19th century. Widespread use of reinforced concrete began in the United States about 1900. It was first designed by a few specialists, especially in Europe, in accordance with special reinforcement "systems."

As the art of using reinforced concrete developed, the sufficiency of the resistance of the plain bar to slippage was questioned and attempts were made to deform bars. Laboratory tests of bond were made as early as 1894 but were never extensive. Starting about 1943 the AISI organized a committee of reinforced concrete research with the object of increasing our knowledge on the effective and economical use of reinforcement.

LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE, CHAPTER 1—HISTORY AND SCOPE.44-21

F. R. McMILLAN and I. L. TYLER — Feb. 1948, pp. 441-456 (V. 44)

A comprehensive investigation of portland cement in concrete is introduced by this brief paper outlining: (1) history of the study — advisory committee membership, development of the program, financing and scope of the investigation; (2) selection of cements; (3) tests of cements; (4) construction projects —test roads, exposure to sea water and sulfate soils, concrete in thin sections, experimental farms and inspection of field projects, in which the behavior of cements will be studied over a period of years.

The paper is the first of a series of as yet an undetermined number reporting the results of the long-time study.

(See also 44-26, 44-33, 44-38, 46-17, 47-51, 49-42, 52-13, 54-27, and 54-59)

ANALYSIS OF NORMAL STRESSES IN REINFORCED CONCRETE SECTIONS UNDER SYMMETRICAL BENDING ...44-22

MICHEL BAKHOUM — Feb. 1948, pp. 457-484 (V. 44)

Gives an analytical method for checking normal stresses in reinforced concrete sections under eccentric forces, without the usual procedure of dividing the section into small strips. A simple solution is also given for the case of simple bending. Both solutions are further simplified by the use of curves and tables, which apply to all arrangements of reinforcement and can be used for almost all practical cases.

A procedure has been devised to apply the same methods to the case in which concrete in tension is taken into consideration even though the modulus of elasticity in tension differs from that in compression. Some examples are given for both cases.

CREEP OF STEEL AND CONCRETE IN RELATION TO PRESTRESSED CONCRETE 44-23

GUSTAVE MAGNEL — Feb. 1948, pp. 485-500 (V. 44)

Outlines methods and results of creep tests performed on three different samples of steel wire under constant load and constant length conditions. Preparation of concrete specimens prestressed by use of these same wires is described. Load tests on these specimens and nonprestressed concrete are compared and the differences in deformation are attributed to the combined creep of steel and concrete. Results of creep tests on steel alone are applied to ascertain creep of concrete alone. Concrete shrinkage, steel strains, and steel and concrete creep are considered in recommending an anticipated percentage loss of prestress for design purposes.

REPAIRING CONCRETE HYDRAULIC STRUCTURES 44-24

CLAUDE GLIDDON — Mar. 1948, pp. 513-520 (V. 44)

Seventeen years experience of the Gatineau Power Co. indicate that ordinary concrete, reinforced and unreinforced, can be successfully used to repair hydraulic structures. Elimination of leakage prior to surface repair, good bond between new and old concrete, and shrinkage of new concrete during setting to prevent cracking are important. A procedure for repair is outlined stressing the importance of experienced labor and supervision and briefly describing grouting, selection of materials, design strengths of concrete, preparation of surface, vibration forms, curing, and joints.

BOND AND ANCHORAGE.........44-25

T. D. MYLREA — Mar. 1948, pp. 521-552 (V. 44)

Pull-out resistance of embedded bars and bond strength in simple beams are compared. A study of distribution of bond unit stress, and of safety against bond failure in beams of uniform depth indicates the bond formula is safe in most such beams with bars extending full length. When all bars are full length, there is a definite relation between bar length and diameter, beyond which bond unit stress need not be computed. When steel tension is high, permissible bond unit stress is low.

Bar extension and hooks are evaluated according to efficiency as anchors under high bond stress. Suggestions are made as to length of bearing on supports and cutoff points. It is shown that in wedge-shaped beams, brackets, tapered footings and the like, bond formulas now in use may give deceptively low stresses.

LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE, CHAPTER 2—MANUFACTURE OF THE TEST CEMENTS 44-26

F. R. McMILLAN and W. C. HANSEN — Mar. 1948, pp. 553-604 (V. 44)

This paper is the second chapter of a series of reports. It contains a brief description of the manufacturing process of the 27 cements selected for this study of concrete durability. The cements are listed by type and geographical location of the plants; chemical analyses of the raw materials are given and tabulations presented showing the following operations: preparation of the kiln feed; burning, cooling and storing of clinker; grinding and storing of the cements.

Data are given on kiln temperatures, uniformity of the clinker weights and cement temperatures.

(See also 44-21, 44-33, 44-38, 46-17, 47-51, 49-52, 52-13, 54-27, and 54-59)

PRESIDENT'S ADDRESS 44-27

STANTON WALKER — Apr. 1948, pp. 605-612 (V. 44)

Mr. Walker discusses the unique position of the Institute as a professional organization—its administrative setup, its publication policies and achievements, its committee undertakings—presenting a qualitative evaluation of its accomplishments.

EFFECT OF CARBON BLACK AND BLACK IRON OXIDE ON AIR CONTENT AND DURABILITY OF CONCRETE....44-28

THOMAS G. TAYLOR — Apr. 1948, pp. 613-624 (V. 44)

The practice of using air-entraining cement and air-entraining admixtures has made it necessary to re-examine many of the materials added to concrete to determine their effect on these types of concrete. Paper reports tests made to determine the effect of certain coloring agents on the air content and durability of concrete.

The tests indicate that some materials when added to concrete reduce the capacity of the cement to entrain air and thereby reduce the resistance of the concrete to freezing and thawing. A recommended procedure for evaluating coloring agents for use in air-entrained concrete is given.

AGGREGATE REACTION WITH CEMENT ALKALIES 44-29

WILLARD H. PARSONS and HERBERT INSLEY — Apr. 1948, pp. 625-632 (V. 44)

Experiments reported tend to support and amplify Hansen's hypothesis on alkali-aggregate reaction. Test specimens composed of high-alkali cement and reactive aggregate (opal) were exposed to conditions promoting the reaction resulting in cracking and expansion. Petrographic examination at frequent intervals during the course of exposure indicated that the chemical reaction results in liquefaction, swelling, and migration of the reaction products. The liquefied gel produced by the reaction fills pores existing in the specimen. After the pore is filled, a reaction at the pore wall occurs to form a dense, semipermeable membrane through which osmosis takes place, resulting in expansion and cracking.

RESTORATION OF BARKER DAM....44-30

RAYMOND E. DAVIS, E. CLINTON JANSEN, and W. T. NEELANDS — Apr. 1948, pp. 633-668 (V. 44)

There is described a unique method of stabilizing and restoring a 37-year old dam. A 12,500 cu yd blanket of concrete made by the Prepacked Concrete method was bonded to the upstream face and was contained behind a permanent form made of precast concrete slabs. The work of erecting the slabs and placing the coarse aggregate behind them was done in the dry during the cold winter months when severe weather conditions would have made impracticable the placement of conventional concrete. When the reservoir was nearly filled with cold water from melting snow in the mountains, and the dam was in the position of nearly maximum downstream deflection, the aggregate mass was grouted under water as a continuous operation without cold joints over the full length and height of the dam. The average maximum temperature of the prepacked concrete mass during the hardening period, which usually occurred about 4 days after grouting, was only 63 F.

NORMAL STRESSES IN REINFORCED CONCRETE SECTIONS UNDER UNSYMMETRICAL BENDING 44-31

MICHEL BAKHOUM — Apr. 1948, pp. 669-692 (V. 44)

Treats the problem of unsymmetrical bending, whether pure or compound, in reinforced concrete sections of any shape. Three general solutions (method of centers of action of steel and concrete, product of inertia method and method of successive trial) have been developed. Each can be used separately for finding the exact position of the neutral axis and consequently the distribution of stresses. The three solutions are based on the assumptions of the standard theory and, of course, lead to the same results. However, under certain circumstances the use of one solution may be simpler than the other two. From the results of the numerous examples that have been solved recommendations are given for making the first assumption of the direction of the neutral axis in such a way that the number of trials is considerably reduced.

PROGRESS WITH CONCRETE — 1923-1948 44-32

A symposium with contributions by WALDO G. BOWMAN, P. H. BATES, J. C. PEARSON, ROY W. CRUM, FRANK E. RICHART, and RODERICK B. YOUNG — Apr. 1948, pp. 693-744 (V. 44)

Five past presidents of the American Concrete Institute and an editor of engineering periodicals review and evaluate a quarter-century of progress in concrete theory design and practice. Problems of 25 years ago are recalled, and the extent to which they have been solved, discussed. Landmarks of progress are enumerated, today's problems (both new and old) are acknowledged. Difficulties encountered in formulating standards and specifications are reviewed; progressive changes in cement specifications are listed. Suggestions are made for continuing research programs and improved research techniques. Inspection practices are criticized and corrections suggested, the importance of consistency control and air entrainment effect are stressed. The history of alkali reaction studies is outlined. Important steps in structural design and theory are pointed out in some detail, there is a similar emphasis on progress of durability studies, and special mention is made of developments in highway construction.

LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE, CHAPTER 3 — CHEMICAL AND PHYSICAL TESTS OF THE CEMENTS.44-33

WILLIAM LERCH and C. L. FORD — Apr. 1948, pp. 745-796 (V. 44)

The results of extensive physical and chemical tests of the 27 cements used in the long-time study are reported in this chapter. ASTM methods of test were followed when available. Other test methods used are described or reference given to published description.

(See also 44-21, 44-26, 44-38, 46-17, 47-51, 49-52, 52-13, 54-27, and 54-59)

PREFABRICATED PUMICE CONCRETE HOUSES 44-34

H. L. MATHEWS — May 1948, pp. 797-812 (V. 44)

Lightweight precast slab construction was chosen for a 380-dwelling navy housing project in the Mojave Desert. Finished cost of these two-bedroom, single-family, single-story houses was $7240, including air conditioning, gas heater, gas kitchen range, electric refrigerator, plumbing, and electrical equipment. Pumice aggregate concrete weighing not more than 75 lb per cu ft, with 1500 psi 28-day strength, was specified.

Paper gives sieve analysis of pumice aggregate, mix proportions, and design, and thermal properties of pumice concrete, assembly line production of the precast slabs is described, with details of handling, finishing, and steam curing included. Time of each operation in the process is given. Assembling of the houses—setting, aligning and anchoring wall slabs, placing and joining roof slabs, installing utilities conduits, and placing the concrete floor— is described. Experiences with surface treatment for floors, roofs and both interior and exterior walls are recounted. Future of prefabricated concrete houses, pumice concrete in particular, is discussed.

DEVELOPMENT OF TILT-UP CONSTRUCTION 44-35

C. A. CLARK — May 1948, pp. 813-820 (V. 44)

The idea of casting large wall sections horizontally on the floor and tilting them to a vertical position has been used for many years but only in the last several years has it received wide recognition. The method offers architectural flexibility and variations in exterior surface treatment. Panel lengths and heights and window and door openings can be easily adapted to meet requirements of standardized or individually designed buildings. Insulation and vapor seals can be attached to the inside of the wall (under side) before placing the concrete. Electrical and other conduits and outlet boxes are installed before concrete is placed.

The tilt-up method makes extensive use of power equipment and lends itself to many economies of assembly-line techniques.

DURABILITY OF CONCRETE EXPOSED TO SEA WATER AND ALKALI SOILS — CALIFORNIA EXPERIENCE 44-36

THOMAS E. STANTON — May 1948, pp. 821-848 (V. 44)

This article is a continuation of a discussion on the same subject published in the ACI Journal for March-April, 1938. Data not available at that time which have since come to light contribute materially to our understanding of the causes of concrete deterioration when exposed to sea water and alkali soils and appropriate corrective or protective measures.

The principal new developments are:

1. The discovery that one cause of excessive expansion and cracking of concrete is an adverse reaction between certain minerals in the aggregate and the alkali constituents of portland cement, thereby providing an avenue for the ingress and deposit of aggressive salts in excessive amounts. The cure in this case is to use either a nonreactive aggregate or a low alkali or suitable portland-pozzolan cement.

2. Positive evidence that the resistance of concrete to sulfate attack is materially improved through the use of a suitable air entraining agent. Accelerated tests indicate the ASTM approved air-entraining agents Vinsol resin and Darex are suitable and effective.

THERMAL INSULATION OF CONCRETE HOMES 44-37

ARTHUR STONE — May 1948, pp. 849-876 (V. 44)

Describes the value of adequate thermal insulation for concrete homes. With the wide range in types of insulating materials now available, concrete homes can be just as comfortable winter or summer as the best type of wood frame construction, with the added advantage of fire resistance and low annual cost of the concrete construction.

When effective vapor barriers are provided along with the insulating material, condensation, and dampness within the wall, floor, or ceiling is avoided. The use of a vapor barrier will also help to conserve moisture within the home resulting in a somewhat higher relative humidity which will contribute materially to the physical comfort and health of the occupants in cold weather.

Adequate insulation of the walls, floors, ceilings, or roofs should be accompanied by corresponding attention to reduction of heat loss through use of storm windows and doors and by weatherstripping and calking.

LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE, CHAPTER 4 — MICROSCOPICAL STUDY OF CLINKERS 44-38

L. S. BROWN — May 1948, pp. 877-924 (V. 44)

Records the petrographic studies made on the 21 lots of clinker manufactured for the 27 long-time study cements. These studies showed that nine entities were regularly determinable, these being C_3S, C_2S, C_3A, C_4AF, free MgO, a dark prismatic mineral, glass, and a microscopically undifferentiated complex. Percentages of these mineral phases were measured on polished sections, by a Wentworth integrating stage, for each lot of clinker. The measurements, representing essentially the mineral composition of the cements, are presented in tabular form. Paper also is concerned, on the one hand, with the history and techniques of clinker mineral identification and, on the other hand, with correlations between the mineral compositions and various other features or properties of the clinkers and the cements.

(See also 44-21, 44-26, 44-33, 46-17, 47-51, 49-42, 52-13, 54-27, and 54-59)

CONCRETE PAVEMENTS ON THE GERMAN AUTOBAHNEN 44-39

F. H. JACKSON and HAROLD ALLEN — June 1948, pp. 933-976 (V. 44)

The inspection on which this paper is based was prompted by a desire to reconcile conflicting reports which have come out of Germany during the last 3 years regarding the performance of concrete pavements on the autobahnen as compared to the performance of similar pavements in this country. The survey was made during the summer of 1947 and covered approximately 1000 miles of four-lane dual-pavement in the British and American zones of occupation.

Condition of the German pavements is discussed from the standpoint of both structural performance and quality of concrete per se. All of the structural defects which usually develop in concrete pavements in the United States were found. However, aside from transverse cracking, which was quite common, defects such as joint spalling, joint faulting, settlement, etc., were not serious except in the area immediately north and south of Frankfurt. It is believed that the comparative freedom of the German motor roads from structural defects is due primarily to two factors: the comparatively small amount of heavy truck traffic using these roads, now and in the past, and the comparatively mild climate.

The soils of Germany vary from cohensionless sands to plastic, silty clays and clays. Most of the silty clays examined on the system were of such a nature as to require careful moisture control for adequate compaction. Such soils would be subject to frost heave under adverse drainage conditions. Pumping at joints would occur on these soils if free water entered expansion joints or cracks and if a sufficient number of heavy loads passed over the pavement. The practice of placing a layer of granular material under the pavement was, no doubt, a contributing factor in the prevention of mud pumping in such cases.

The concrete was, almost without exception, of excellent quality. Scaling was confined almost entirely to the sections between Munich and Salzburg. Disintegration was practically nonexistent. An outstanding surface characteristic was the absence of the heavy layer of surface mortar which is frequently found on pavements in the United States. It is believed that the excellent quality of the concrete is due to (1) the excellent quality of the aggregates, (2) the low water-cement ratio, (3) thorough consolidation by tamping and vibration of a dry mixture with a maximum aggregate size of about 1 in., (4) thorough curing, and (5) the comparatively mild climate. The effect of the cement is not clear. German cements were definitely inferior as judged by modern American standards. Whether they were actually inferior remains to be seen.

As the result of their survey the authors recommend that steps be taken to initiate a comprehensive program of research on each of the following subjects:

1. A program to study the possibility of insuring greater uniformity in concrete for pavements by reducing the maximum size of the coarse aggregate.

2. A program to develop more effective methods of compacting concrete in pavements by mechanical means, such as vibration, tamping, etc.

3. A program to study the effects of variations in the chemical composition of cements and the methods of manufacturing cements on the properties of concrete. Work of this nature should be carried out by the manufacturers and might well be accomplished by an extension of the present program of the Long-Time Study to cover these variables.

CONCRETE DETERIORATION IN A SHIPWAY 44-40

RUTH D. TERZAGHI — June 1948, pp. 977-1008 (V. 44)

Concrete in the gate structure of a large submerged shipway in the southeastern United States began to deteriorate 2 years after construction was completed. The defects included abnormally low strength of some of the concrete and numerous cracks which became progressively wider. An investigation of the cause of deterioration, begun at this time, in-

cluded microscopic examination and chemical analyses of core specimens, chemical analyses of specimens of water issuing from relief pipes in the pier, frequent crack surveys, periodic measurement of change of length of the pier and change of width of two of the chief cracks, and compression tests on selected core specimens. On the basis of the data obtained by these various methods, it was concluded that detrimental processes of two types are taking place in the concrete. One of these causes expansion of the central part of the pier and thus leads to cracking at the pier surface. This process is ascribed to a reaction between hydrated cement and sulfates and/or other substances normally present in sea water. The other process produces a local softening or even complete disintegration of the concrete. It appears to be due chiefly to a chemical reaction between the paste and carbon dioxide which is present in unusually high concentration in the water percolating through the structure.

EFFECT OF VARIOUS COARSE AGGREGATES UPON THE CEMENT-AGGREGATE REACTION 44-41

C. H. SCHOLER and W. E. GIBSON — June 1948, pp. 1009-1032 (V. 44)

Concrete made with native Kansas sand-gravel (an aggregate containing little coarse material) began, about 1930, to show abnormal expansion, map cracking, and loss in flexural strength. Tests were made by the Engineering Experiment Station at Kansas State College, in cooperation with several other agencies, to determine the causes of and prescribe cures for this condition. Concrete samples were made with 24 different cements using two trouble-making aggregates and were submitted to varying exposure tests. It was found that deterioration varied with the different cements, but there was no consistent relation between cement composition and extent of deterioration. Hence it was concluded that the cement-aggregate reaction causing deterioration was not primarily an alkali-aggregate reaction. Extensive tests on concrete made of sand-gravel combined with some coarser aggregates indicate reduced expansions and less tendency toward deterioration. Addition of 25 percent or more (by weight) coarse limestone is adequate to secure satisfactory service; for coarse aggregate such as Lincoln sandstone, as much as 40 percent may be required.

EVALUATION OF AGGREGATE PERFORMANCE IN PAVEMENT CONCRETE 44-42

H. S. SWEET and K. B. WOODS — June 1948, pp. 1033-1040 (V. 44)

Consists essentially of a review of published information on aggregate as a variable influencing the durability characteristics of portland cement concrete. Covers the evaluation techniques which have been used in field performance studies, particularly with respect to isolating the causes of the performance. Some emphasis has been placed on such studies made in Indiana where it has been found that many miles of concrete pavements have deteriorated when certain coarse aggregates were used regardless of other variables, such as cement, fine aggregate, traffic, etc. In contrast, many more miles of Indiana pavements, constructed with other coarse aggregates, are in excellent condition after as many as 20 years of service. Mentions but does not treat the reactions between high alkali cements and certain aggregates. It is concluded that aggregate acceptance tests in common use are not adequate to differentiate between good and bad aggregate materials.

LABORATORY MEASUREMENTS OF STRESS DISTRIBUTION IN REINFORCING STEEL 44-43

DOUGLAS McHENRY and W. T. WALKER — June 1948, pp. 1041-1056 (V. 44)

The SR-4 strain gage, an electrical device somewhat smaller than a postage stamp and scarcely any thicker, has been used successfully to measure stresses in reinforcing steel embedded in concrete. Paper gives typical laboratory test results on the stress distribution along the steel of simple reinforced beams before and after cracking, and compares these results with the stresses computed by conventional methods. Attention is called to some of the many possible applications of this gaging method as well as to its limitations. The method of attaching and waterproofing the gages is described in an appendix.

Proceedings V. 45

RECOMMENDED PRACTICE FOR WINTER CONCRETING METHODS (ACI 604-48) .45-1

COMMITTEE 604 — Sept. 1948, pp. 1-20 (V. 45)

Supersedes 44-13
Superseded by 52-60

This ACI standard establishes methods of cold-weather concreting for thin sections and mass concrete. Heating of materials, accelerators and antifreezes, curing and temperature records during curing, subgrade (or base) preparation, protective coverings during curing, and form removal are discussed for both types of job, and preferred methods are indicated. An appendix entry outlines objectives of the special winter methods with background material which indicates the "why" of some of the recommended practices. Charts in the appendix indicate effect of curing temperature on concrete strength, and a list of 135 selected references to periodical literature on winter concreting methods is included.

RELATIVE STRENGTHS OF PORTLAND CEMENT MORTAR IN BENDING UNDER VARIOUS LOADING CONDITIONS. . .45-2

JACOB PORTER FRANKEL — Sept. 1948, pp. 1-32 (V. 45)

Assuming the behavior of standard mortar to be similar to that of plain concrete, tests were performed on 99 small mortar beams under sixth-, third- and center-point loading to verify the applicability of the statistical theory of the strength of brittle materials to concrete structures. The theory, as first developed by Weibull, is briefly analyzed, compared to the methods used by Tucker, and finally applied to the tests at hand. Agreement between the theoretical and experimental findings is so close as to warrant future testing on plain concrete specimens.

TERRAZZO AS AFFECTED BY CLEANING MATERIALS 45-3

D. W. KESSLER — Sept. 1948, pp. 33-40 (V. 45)

Effect of cleaning materials on terrazzo was studied using solutions of the following detergents: soda ash, trisodium phosphate, and synthetic sulfonate. Seventy-six different aggregates were used in preparing terrazzo disks which were moist cured 3 months and then surface ground to form a shallow dish. Detergent was allowed to stand in dish 30 min before rinsing and drying (at 105 C). This testing cycle was repeated until deterioration tendencies were established. Soda ash solution proved much more destructive than the trisodium phosphate, however, up to the time of writing (after 850 cycles) the synthetic sulfonate had caused no failure.

TRANSPORTING READY-MIXED CONCRETE IN OPEN DUMP TRUCKS. 45-4

R. A. BURMEISTER — Sept. 1948, pp. 41-56 (V. 45)

Milwaukee experience in hauling air-entrained concrete in open dump truck bodies is recorded. Slump, air content, specific weight, compressive strength, and workability tests were made on concrete before and after a trial run over bumpy pavement. Some similar tests were made on concrete being placed in a Milwaukee street after open truck transportation. The author concludes that open trucks for hauling ready-mixed, air-entrained concrete are satisfactory when air content is between 3 and 6 percent (5 to 6 sacks cement per cu yd) and hauling time is 45 min or less, provided that aggregate moisture, grading, and slump are carefully controlled.

A STUDY OF ALKALI-AGGREGATE REACTIVITY BY MEANS OF MORTAR BAR EXPANSIONS 45-5

T. M. KELLY, L. SCHUMAN, and F. B. HORNIBROOK — Sept. 1948, pp. 57-80 (V. 45)

Many types of aggregate were combined in varying amounts and sizes with high- and low-alkali cements and formed into 1 x 1 x 10-in. mortar bars. The bars were stored either at 70 F or at 100 F and their expansions measured at ages ranging from 1 month to 4 years.

In combination with high-alkali cements, opal, opaline chert, and a siliceous dolomitic limestone were found to cause greatest expansion. Certain aggregates containing volcanic glasses and some natural sands and gravel also caused excessive expansion; with one exception, these sands contained small amounts of opal.

Greatly delayed expansion resulted with the fine sizes of opal, particularly in combination with high-soda cement. Similar behavior resulted with minus No. 81 size opal and low-alkali cement with either Na_2SO_4 or K_2SO_4 additions.

Materials such as dehydrated kaolin, soda feldspar, magnesium fluosilicate, acetic acid, and calcium hydroxide added in small amounts as correctives were ineffective. However, diatomaceous earth in sufficient quantity as a cement replacement eliminated expansion.

REINFORCED CONCRETE WALL AND COLUMN FOOTINGS

PART I 45-6a

FRANK E. RICHART — Oct. 1948, pp. 97-128 (V. 45)

PART II 45-6b

FRANK E. RICHART — Nov. 1948, pp. 237-260 (V. 45)

Presents, in two parts, a report on an experimental investigation of reinforced concrete footings. It represents the first extensive study of the subject since the well-known work of Talbot in 1913. In the meantime there have been many developments in materials, as well as in design methods.

Important developments from these tests include the following: (a) definite proof that the tensile and bond resistance depend on the bending moment and shear found by statics by consideration of the full applied load, and not 85 percent thereof, as assumed in current building codes; (b) hooked ends of bars showed no particular advantage in bond resistance over straight bars, particularly when deformed bars of new improved types were used, (c) hooked bars produced little effect on resistance to diagonal tension, much less than is commonly assumed, (d) welded mats proved particularly effective in resisting end slip of bars, (e) footing caps or piers are effective in reducing the amount of reinforcement and in increasing the load capacity of footings; and (f) diagonal tension seems to be the point of weakness in current design practice. The factor of safety of thin footings in this respect appears greater than in thick footings, and is generally greater in rectangular than in square footings, when the conventional methods of computation are used.

In these tests, major emphasis has been placed on the isolated column footing. Principal attention has been given to the resistance of footings to failure by bond, diagonal tension and tension in the steel. Test footings were designed to produce these various types of failure. In addition, studies were made of the behavior of rectangular footings and footings having intermediate capitals or piers.

The tests featured measurements of tensile and compressive strains, deflections, and slippage of bars. In some of the tests three grades of concrete were used, in others, five types of reinforcing bar were employed. In most of the tests, the footings were 7 ft square. They were supported on a bed of steel springs and tested in a large testing machine.

Paper merely attempts to present and interpret the test results, and does not offer recommendations as to possible changes in design procedures at this time.

LATTICE ANALOGY IN CONCRETE DESIGN 45-7

DOUGLAS McHENRY — Oct. 1948, pp. 129-140 (V. 45)

The lattice analogy is a scheme for solving two-dimensional stress problems in which the involved mathematical methods of the theory of elasticity are replaced by simple computations. The solid section is replaced by an equivalent lattice or framework which may be solved by methods applicable to indeterminate structures. Stress distribution in sections of complex shape and with complex loading may be determined by successive approximations which involve only substitution in simple equations. The method is illustrated by application to the problem of stresses in a deep beam with off-center loading.

STRENGTH OF PRECAST CONCRETE FLOOR JOISTS 45-8

JACOB FELD — Oct. 1948, pp. 141-148 (V. 45)

The strength and usability of precast concrete floor joists left in the open without any protection for a year, when a housing project was abandoned, were proved by load test on a slab section incorporating the poorest joists. Paper describes the condition of the joists, the load test results and indicates that a greater tolerance can be safely permitted in the visible defects of precast concrete joists.

EFFECT OF ENTRAINED AIR ON CONCRETES MADE WITH SO-CALLED "SAND-GRAVEL" AGGREGATES..... 45-9

PAUL KLIEGER — Oct. 1948, pp. 149-164 (V. 45)

Sand-gravel aggregates (maximum particle size 3/8 in.) used with non-air-entraining cement produce concretes containing from 3 to 4 percent air. The same mixes made with air-entraining cement and the sand-gravel aggregates have air contents from 8 to 13 percent. Effect of this larger amount of entrained air is given in terms of tests of flexural and compressive strength, freezing and thawing resistance, and length changes in varying storage conditions. Effect of "sweetening" the sand-gravel by addition of 30 percent of coarser aggregate is noted.

BURNED SHALE AND EXPANDED SLAG CONCRETES WITH AND WITHOUT AIR-ENTRAINING ADMIXTURE 45-10

P. H. PETERSEN — Oct. 1948, pp. 165-176 (V. 45)

The physical properties of several lightweight aggregate portland cement concretes made with burned shale or expanded slag were investigated at the National Bureau of Standards. Three grades of concrete were made with each aggregate. Air-entrainment greater than 20 percent is reported for the mixtures leanest in cement, an air-entraining admixture being used to increase the workability of all but the richest concretes. Compressive, flexural, and bond strength data are given as well as resistance to heat transfer, rain penetration, and water penetration by capillarity. Also included are the coefficients of thermal expansion, shrinkage, and values for change in length due to wetting and drying.

CEMENSTONE PRECAST CONSTRUCTION 45-11

A. C. GRAFFLIN — Nov. 1948, pp. 193-204 (V. 45)

Standardized precast reinforced concrete structural members and panels point toward economy in fireproof construction of ordinary buildings up to four stories. The method described has been so developed that architects and engineers can select from tables reinforced concrete beams, columns, roof, floor, and wall panels in the same manner as for structural steel. Design is in accordance with the ACI Code and costs compare favorably with similar structures framed of steel and fireproofed with concrete.

SAND GRADING INFLUENCE ON AIR ENTRAINMENT IN CONCRETE.....45-12

M. A. CRAVEN — Nov. 1948, pp. 205-216 (V. 45)

Four series of mixes with varying air-entraining agents, cement factors, and sand grading and content were prepared to observe sand grading effect on concrete. Graphic record is presented of air content and W/C plotted against fineness modulus of sand, flow and compressive strength plotted against fineness modulus of sand, and air content plotted against percent of No. 30—No. 50 sand and total sand percentage. Generally the percentage of air entrained in concrete increased with decrease in fineness modulus of sand. Quaitity of air appears to be a function of the quantity of No. 30—No. 50 sand. Effect of grading and quantity of sand on other properties of fresh and hardened concrete is noted.

INFLUENCE OF SIZE GRADING OF SAND ON AIR ENTRAINMENT 45-13

E. W. SCRIPTURE, JR., F. B. HORNIBROOK, and D. E. BRYANT — Nov. 1948, pp. 217-228 (V. 45)

Field reports indicated difficulty with certain sands in securing the desired amount of entrained air; this was frequently attributed to the size grading of the sand, particularly to a deficiency in the finer fractions. An experimental investigation was undertaken in view of the paucity of published data on this subject. Mixes of sand and water alone, 1:4 and 1:2 mortars, and concrete mixes were made with and without air-entraining agents and the air contents determined. While size grading of the sand had a great influence on air entrainment in a mixture of sand and water alone, this effect was smaller in mortars and very small in concrete mixes. It was found that maximum air was entrained by the 28-48 mesh size sand rather than the 48-100 mesh size.

USE OF PREPACKED AGGREGATE CONCRETE IN MAJOR DAM CONSTRUCTION 45-14

PAUL BAUMANN — Nov. 1948, pp. 229-236 (V. 45)

Sets forth the method of construction of a major gravity dam whereby the average temperature of the mass concrete may be controlled within the mean annual and the dry shrinkage reduced to a fraction of that of conventional concrete by prepacking of the coarse aggregate to a density corresponding to 30 percent voids; precooling the aggregate; the intrusion of the coarse aggregate by mortar with a cement content of 2 sacks per cu yd or less; and the internal post-cooling, curing and draining of the mass concrete.

RATIONAL ANALYSIS AND DESIGN OF TWO-WAY CONCRETE SLABS......45-15

C. P. SIESS and N. M. NEWMARK — Dec. 1948, pp. 273-316 (V. 45)

A new method for the design of two-way building slabs is proposed and its step-by-step development is described. A new moment distribution procedure is used to compute moments in a number of rectangular slabs continuous over rigid beams. Several variables are studied in the analyses and include: the ratio of sides, the effect of discontinuous edges, the torsional stiffness of the beam, various types of loading, and combinations of panels of various sizes and shapes. Certain conclusions are stated regarding the types of loading to be considered and the values of beam torsional stiffness to be assumed in the development of the design procedure.

Moments obtained in the foregoing analyses are modified to take into account the effect of additional variables. First, the slab moments are increased by various amounts as a result of the deflection of the beams. Next, separate coefficients for dead and live load are replaced by combined coefficients for a live load-dead load ratio of 3.0. Then follows a study to determine the effect of discontinuous edges, and this variable is eliminated from the procedure. Finally all slab moments are reduced by 20 percent in recognition of the redistribution of moments at high load. Additional studies are then made of the distribution of moments across the width of the slab and of the moments to be used for the design of the beams to complete the development of the design procedure.

A proposed design procedure is presented in specification form and is compared with other procedures of a similar nature and with the moment distribution procedure described in the appendix.

CORROSION RESISTANCE TESTS OF CONCRETE FLOORS — WITH AND WITHOUT METALLIC AGGREGATE 45-16

E. W. SCRIPTURE, JR., and C. H. SAKRYD — Dec. 1948, pp. 317-324 (V. 45)

An attempt has been made to determine the conditions under which concrete floors can be expected to give good service. Resistance to abrasion was determined on specimens with and without metallic aggregate after exposure to typical reagents selected from the groups described by the Joint Committee as having corrosive effects of an intermediate nature between no attack and severe attack. On the basis of the experimental results the reagents in the Joint Committee report have been classified in relation to anticipated service of concrete floors.

FLEXICORE PRECAST FLOOR AND ROOF SLABS 45-17

GAYLE B. PRICE — Dec. 1948, pp. 325-340 (V. 45)

Describes briefly the design, manufacture, erection procedures and use of Flexicore slabs in precast concrete floor and roof systems. The Flexicore slab has a standard cross section 12 in. wide and 6 in. thick, lightened by two holes 4⅝ in. in diameter running the full length of the slab which is made in inch variations of length up to a maximum of 22 ft 6 in. Reinforcement consists of two bars in the top of the slab for "handling" stresses and two or three prestressed tension bars at the bottom to take care of bending moment.

PROPOSED RECOMMENDED PRACTICE FOR THE APPLICATION OF PORTLAND CEMENT PAINT TO CONCRETE SURFACES 45-18

COMMITTEE 616 — Jan. 1949, pp. 353-368 (V. 45)

Supersedes 38-30
Superseded by 46-1

This report is a studied revision by a reorganized committee of the previous report of Committee 616 published in June 1942, based on criticisms of that report plus information from more recent tests and experiences. Included are recommendations for appropriate usage, age of concrete, preparation of surface, and the preparation, application and curing of portland cement paint. Three appendixes discuss composition, manufacture and storage, and general characteristics and factors affecting durability.

DRY MORTAR AS A BEARING AND GROUTING MATERIAL.......45-19

BOYD S. BROOKS — Jan. 1949, pp. 369-380 (V. 45)

In 1939, at the navy's new David Taylor Model Basin at Carderock, Md., there was an urgent need for a non-shrinking bearing material to be used under the cast-steel "chairs" which support the rails on which the towing carriages run. Requests for information concerning materials and installation procedures produced such varied answers that investigation was started to find the best material and the best procedures for placing it.

The bearing material selected for use was 1:3 portland cement mortar, with 4.13 gal. of water per sack of cement. This was rammed firmly into place.

At the time of writing, this bearing material was in place about 9 years under extremely severe conditions and without exception had proved to be excellent in function and condition.

DIRECT DIMENSIONING OF RECTANGULAR SECTIONS 45-20

MICHEL BAKHOUM — Jan. 1949, pp. 381-396 (V. 45)

On the basis of the standard theory for reinforced concrete design, methods have been derived for the direct dimensioning of rectangular sections, with or without compression reinforcement, when subpected to simple bending, eccentric compression or eccentric tension. Two cases are considered: when the depth of the section is fixed and when it is not fixed. The conditions leading to minimum reinforcement are also studied. The solutions developed have been simplified by the use of curves which are applicable for pure bending as well as for eccentric compressive or tensile forces and cover any values of f_c, f_s and n. The curves allow making a variety of designs in a relatively short time and thus help in choosing the most economical or most suitable section.

STRENGTHENING BRIDGE SLABS WITH GROUTED REINFORCEMENT. .45-21

S. O. ASPLUND — Jan. 1949, pp. 397-408 (V. 45)

On the project described the negative reinforcing bars settled as much as 2½ in. out of correct position. Various means for incorporating negative reinforcement at correct height in the finished structure are discussed. The method selected of grouting additional bars in grooves cut with the aid of a diamond saw is described. Tests on beam specimens made with some bars encased in the concrete and some bars grouted into diamond-sawed grooves, give results identical with those to be expected for all bars normally encased, ultimate strengths conform closely to the plastic bending capacity of reinforced concrete according to design methods originated by Whitney.

COMPARATIVE DESIGNS OF A SEGMENTAL SKEWED FRAME CONCRETE BRIDGE BY THE STRAIGHT LINE AND PLASTIC THEORY METHODS 45-22

MILTON BRUMER — Jan. 1949, pp. 409-420 (V. 45)

The designs of a segmental skewed frame concrete bridge are discussed and compared as developed by both the straight-line and plastic theory methods. The plastic theory will lead to rigid concrete frames of more economical proportions capable of sustaining equal or greater loads than frames designed by the straight-line method. Effects of volume changes and yielding supports are also of smaller consequence. Deflections may be expected to be greater. The author concludes that further substantiation of the plastic theory is desirable.

SOME FACTORS AFFECTING AIR ENTRAINMENT 45-23

E. W. SCRIPTURE, JR. and F. J. LITWINOWICZ — Feb. 1949, pp. 433-444 (V. 45)

A program was undertaken to investigate the influence of various factors on the amount of air-entrained in concrete mixes with and without air-entraining agent added. The variables so far studied are slump, cement factor, and sand-total aggregate ratio. The results indicate that the two latter factors are of major importance but that slump has less effect. In general, entrained air content increases with increasing slump, decreases with increasing cement factor, sand-total aggregate ratio.

EXPERIMENTAL AIDS IN STRUCTURAL CONCRETE DESIGN 45-24

R. E. GLOVER, O. J. OLSEN, and CARL ZANGAR — Feb. 1949, pp. 445-468 (V. 45)

Statically determinate and indeterminate structures are generally designed by analytical methods. Paper describes several experimental aids which have been used in the design and stress analysis of statically indeterminate structures at the laboratories of the Bureau of Reclamation. These methods are used where analytical procedures cannot conveniently be applied. Described herein are photoelastic methods using both the polariscope and interferometer, the Beggs Deformeter, Stresscoat, and electric SR-4 strain gages. Applications are given for each method.

PRACTICES, EXPERIENCES, AND TESTS WITH AIR-ENTRAINING AGENTS IN MAKING DURABLE CONCRETE 45-25

R. F. BLANKS and W. A. CORDON — Feb. 1949, pp. 469-488 (V. 45)

Discusses the advantages of air entrainment with regard to durability, permeability, workability, reduction in alkali expansion, time saving, reduction in water and cement, temperature rise, strength, abrasion resistance, monolithic lightweight concrete, and mass concrete. U. S. Bureau of Reclamation experiences are discussed with regard to pumping, transportation and placing, grading of aggregates, and factors, affecting the amount of air entrained. Air-entraining agents and air-entraining cements are discussed briefly. There is a brief section on the measurements of entrained air in concrete with a recommended procedure.

CONCRETE FLOOR FINISHING 45-26

GERALD MILSOM — Feb. 1949, pp. 489-492 (V. 45)

A concise discussion of the requirements for durable concrete floors including careful selection and control of materials and attention to weather conditions. The importance of proper equipment, working conditions and curing of the finished concrete are emphasized.

PLASTIC FLOW OF CONCRETE AT HIGH OVERLOAD 45-27

J. R. SHANK — Feb. 1949, pp. 493-500 (V. 45)

New data on the plastic flow of concrete prompted a reconsideration of the assumption that plastic flow is directly proportional to the unit stress applied. Tests are described in which deformations of 6 x 12-in. concrete cylinders were measured while under sustained loads approaching the ultimate strength. Plotted data are shown to demonstrate that the change in the rate of plastic flow appears to be uniform up to three-quarters or more of the ultimate strength with an abrupt change at the "true" ultimate strength. Included are other data indicating that the plastic flow curve has the same general form independent of time and applied load leading to a new consideration in expressing factor of safety and developing beam theories on a factor of safety basis.

CONTROL OF CONCRETE PAVEMENT SCALING CAUSED BY CHLORIDE SALTS 45-28

B. D. TALLAMY — Mar. 1949, pp. 513-520 (V. 45)

Under modern traffic requirements on heavily traveled roads salt-treated abrasives will not remove ice quickly enough. As maintenance forces have struggled to meet the demand for uninterrupted service the use of straight salts has become increasingly common. Direct applications of up to 600 lb of salt per two-lane mile are required to combat extreme icing conditions. Pavements constructed to withstand the weak brines deposited by salt-treated abrasives cannot stand up under straight salt. New pavements appear more vulnerable than those 2 or more years old.

The observed resistance to salt action of the oil soaked center streak of uphill traffic lanes led New York state highway engineers to investigate the feasibility of the use of dilute oil applications as a protective measure. Laboratory tests indicate successful results may be expected. In the late summer of 1948 oil spray equipment was developed in time to treat nearly 60 miles of new concrete highways, which should provide a wide base for field observation of the effectiveness of the method.

EXPERIENCE WITH AIR-ENTRAINING CONCRETE IN NEW JERSEY 45-29

CHARLES M. NOBLE — Mar. 1949, pp. 521-528 (V. 45)

Outlines experience in New Jersey with air-entrained concrete utilized primarily to combat attack by deicing chemicals. Damage to concrete

pavements in New Jersey usually is associated with heavy loads. Freedom from disintegration troubles, except in isolated cases, is attributed to excellent aggregates, rigid laboratory control, mix proportioning, inspection of material and plant equipment and construction supervision at the job site.

Air-entrained portland cement concrete was first specified for a concrete pavement contract in 1945 and since then has been used on many contracts with notable success to prevent deterioration due to scaling. The same high standards for materials, mix proportioning, laboratory control, field inspection, and attention to details must be maintained as with ordinary concrete. Pavements thus far constructed in New Jersey with air entrainment have not scaled or shown any signs of disintegration when ice control chemicals have been properly mixed with abrasives at a rate not exceeding 75 lb per cu yd of abrasive. It is too early to form a judgment but indications are the results achieved fully justify the use of air-entrained concrete.

DESIGN DETAILS FOR ARCHITECTURAL CONCRETE 45-30

J. J. HOGAN — Mar. 1949, pp. 529-540 (V. 45)

"To achieve beauty with concrete, as with any other material, requires studied design and skillful craftsmanship" are the words of architect Robert D. Murray. Paper directs attention to the matter of "studied design." The skilled craftsmanship required to construct architectural concrete must be preceded by proper design by the architect and engineer. The designer must understand and appreciate the fundamental requirements of this type of construction. Paper discusses considerations appropriate to achieving the desired texture of surface as affected by form materials selected. Ornamentation should be considered in every detail from the standpoint of practicability. Construction joints are inevitable and should be specified in logical locations. Similarly, control joints should be specified with an understanding of where the most likely cracks due to volume change will occur and the design of reinforcement should be coordinated with the location of the control joints. Numerous illustrations support the text.

CONSTRUCTION PRACTICES FOR ARCHITECTURAL CONCRETE 45-31

E. B. OBERLY — Mar. 1949, pp. 541-552 (V. 45)

Detailed plans and carefully drawn specifications executed by a contractor and superintendent with the know-how of form construction are necessary for good architectural concrete. Paper describes some of the more important construction practices to be considered to achieve the results desired. Form details and concrete quality are discussed in considerable detail, the former being supported by illustrations.

CONCRETE OF THE FUTURE 45-32

ROBERT F. BLANKS — Apr. 1949, pp. 565-568 (V. 45)

Mr. Blanks in his remarks as retiring president, depicts what concrete might be 50 years in the future and discusses the role of the engineer in that era.

CONTROL OF QUALITY OF READY-MIXED CONCRETE 45-33

STANTON WALKER — Apr. 1949, pp. 569-580 (V. 45)

Control of quality of ready-mixed concrete is discussed. The objective of the paper is to pose the more important problems of concrete control, especially those peculiar to ready-mixed concrete, with the view of eliciting discussion, rather than to attempt to outline recommended practices. Both central mixing and transit mixing are discussed. Attention is directed to the mutuality of responsibility of the producers and users in bringing about effective control.

TESTS OF LIGHTWEIGHT-AGGREGATE CONCRETE DESIGNED FOR MONOLITHIC CONSTRUCTION 45-34

WALTER H. PRICE and WILLIAM A. CORDON — Apr. 1949, pp. 581-600 (V. 45)

The characteristics and origin of lightweight aggregates are described and the comparative results of laboratory tests of strength, insulating value, shrinkage, and weathering resistance of concrete made with lightweight aggregates from 17 producers are summarized. Data are included on expanded shale, expanded slag, scoria, pumice perlite, exfoliated vermiculite, and diatomaceous earth.

WHAT HAVE WE LEARNED ABOUT AIR-ENTRAINING CONCRETE? 45-35

J. F. BARBEE — Apr. 1949, pp. 601-612 (V. 45)

A review of ACI published data on air-entrained concrete, this paper summarizes methods of control and the effect of air entrainment on durability, plasticity and workability, strength, resistance to abrasion, and other properties of concrete. The effects of variations in cement and water content, sand-coarse aggregate ratio, mixing time, and the use of calcium chloride as an admixture are described. Changes in technique necessary to successfully place, vibrate, and finish air-entrained concrete are pointed out. A detailed bibliography follows.

DEVELOPMENTS IN THE MANUFACTURE AND TECHNOLOGY OF CONCRETE MASONRY UNITS 45-36

JAY C. EHLE — Apr. 1949, pp. 613-620 (V. 45)

The author touches the high spots of developments in the manufacture of concrete masonry units listing the many problems which now face the manufacturer. Rapid growth of the industry in the past 10 years and the change from tamping to vibration methods is described. New plants are notable for labor saving equipment compared with those of the middle 1930's. In addition to block manufacture and several methods of curing, in use and proposed, the author mentions briefly: block-handling equipment, maintenance and repair of the plant, and the greater supervisory skill now required for successful operation.

LIGHTWEIGHT-AGGREGATE CONCRETE 45-37

RALPH W. KLUGE, MORRIS M. SPARKS, and EDWARD C. TUMA — May 1949, pp. 625-644 (V. 45)

Results of studies on lightweight-aggregate concretes made by the National Bureau of Standards at the request of the Housing and Home Finance Agency (formerly the National Housing Agency) are reported. Aggregates included were expanded clay, shale, and slate; three types of expanded blast-furnace slag, expanded vermiculite and perlite, sintered diatomite and fly ash, and a pumice. Concrete of various proportions was made from these aggregates and determinations were made of the weight per cubic foot, compressive and transverse strength, shrinkage, elastic modulus, absorption, resistance to freezing and thawing, and thermal conductivity. Test results are briefly discussed and summarized.

ANALYSIS OF BUILDING FRAMES WITH UNSYMMETRICAL DIFFERENTIAL SETTLEMENT OF THE FOUNDATIONS 45-38

G. A. LEONARDS — May 1949, pp. 645-652 (V. 45)

The rational design of building frames founded on soil requires a consideration of the effect of settlements caused by the building loads. Paper discusses a procedure for estimating the stresses in such frames due to unsymmetrical differential settlement of the foundations. The procedure is based on the slope-deflection method for analyzing rigid frames, but adapts it to permit a relatively rapid solution by the use of successive approximations.

EFFECTS OF MIXING TIME, SIZE OF BATCH AND BRAND OF CEMENT ON AIR ENTRAINMENT 45-39

E. W. SCRIPTURE, JR. and F. J. LITWINOWICZ—May 1949, pp. 653-664 (V. 45)

A program, partially described in previous papers, to investigate various factors affecting the amount of air entrained in concrete has been continued. The factors covered in this paper are mixing time, size of batch, and brand of cement. The entrained air rises to a maximum in the early stages of mixing and thereafter decreases. Provided mixing is adequate, the size of batch does not appear to affect the amount of air entrained. Wide variations are found in the amounts of air entrained by different cements and it does not appear possible to correlate these variations with any easily and quickly determinable characteristic of the cement.

A METHOD FOR DETERMINING THE AIR CONTENT OF FRESH AND HARDENED CONCRETE 45-40

ROBERT P. VELLINES and THOMAS ASON—May 1949, pp. 665-672 (V. 45)

A method and equipment are described for determining the air content of fresh and hardened concrete based on the principle that air entrained in concrete reacts to external pressures and that volume changes follow the gas laws. The air entrained in hardened concrete reacts to an external pressure in the same manner as an equal volume of air would if it were not surrounded by hardened cement paste. The volume of the air in the specimen is proportional to the time required for a quantity of gas to escape through an orifice from a pressure of p_1 to a pressure of p_2 at a constant temperature.

STUDY OF DUSTY CONCRETE CEILINGS 45-41

JACOB FELD—May 1949, pp. 673-680 (V. 45)

In a large Eastern housing project of two-story concrete buildings considerable trouble was experienced from the "dusting" of first floor ceilings which were cast against new pressed-board forms. The experimental work to isolate the cause, the results of the tests and their interpretation indicated that the dusting was caused by an acidic resinous substance in the surface of the form board. The substance on the surface of the board appeared to be neutralized when the form was used for the first time, inasmuch as reused form boards gave little trouble. In concluding, the author recommends that new types of form material be checked for possible chemical reaction before use in large amounts.

AN INVESTIGATION OF HYDRATING CEMENTS AND RELATED HYDROUS SOLIDS BY DIFFERENTIAL THERMAL ANALYSIS 45-42

GEORGE L. KALOUSEK, CURTIS W. DAVIS, JR., and WILLIAM E. SCHMERTZ—June 1949, pp. 693-712 (V. 45)

Differential thermal analysis was used to identify some of the hydrous solids formed in cements and to follow partially the course of some of the hydration reactions. Pastes of nine commercial portland cement clinkers with and without additions of gypsum were tested at 1, 3, 7, 28, and 90 days and 9 months. Among the individual solids prepared and studied were the calcium sulfoaluminates, hydrous calcium aluminates, lime-silica gels made from different starting materials, with and without additions of Al_2O_3, SO_3 and Na_2O. Thermal analysis results show that the isometric tricalcium aluminate hexahydrate does not form in hydrating cements. The trisulfate form of the calcium sulfoaluminate and the solid solution, $3CaO \cdot Al_2O_3 \cdot CaSO_4 \cdot 13H_2O$-$3CaO \cdot Al_2O_3 \cdot Ca(OH)_2 \cdot 12H_2O$, appear as metastable products only. The stable sulfate-bearing phase has not yet been isolated but presumably is characterized in thermal analysis by an endothermic bulge at 130-140C. A possible role of Fe_2O_3 in the formation of this new phase is considered. The lime-silica gels may occur in two forms, one exhibiting two distinctive thermal changes and the other not showing any marked changes; the former is the more unstable of the two, transforming in prolonged tests to the latter. Alumina appears to stabilize the less stable form of these gels.

STRESSES IN REINFORCED CONCRETE DUE TO VOLUME CHANGE 45-43

FRANK R. BEYER—June 1949, p. 713-724 (V. 45)

A study of stresses set up in reinforcing steel and concrete by volume changes. SR-4 gages were attached to the reinforcing steel and carefully waterproofed. The test specimens were cast in essentially watertight forms. Strain readings began immediately and continued at varying intervals for 3 months. A drift test to determine the effect of diminishing battery potential was included to correct for this variable. Charts are presented to show the stresses measured during the tests. The author concludes that with proper precautions the SR-4 strain gage will measure the actual stress induced by volume changes. These stresses, occurring in reinforced concrete in a definite cycle with respect to time, are appreciable and should be considered in design.

MONOLITHIC AND BONDED FLOOR FINISHES 45-44

MORGAN B. KLOCK—June 1949, pp. 725-732 (V. 45)

The author discusses the design and construction of two types of floor finish. A floor capable of withstanding heavy wear, either bonded or monolithic finish, can be obtained by using a stiff mix of sound, well-graded materials which is thoroughly compacted with a power float. Hard coarse and fine aggregates are recommended for the greatest resistance to wear.

PUMPED CONCRETE FOR ENDERS DAM SPILLWAY 45-45

C. O. CRANE—June 1949, pp. 733-740 (V. 45)

A detailed description is given of the use of pumped concrete in the construction of the concrete spillway for Enders Dam. The author calls attention to the many features of pumped concrete that are of interest and value in considering this method of concrete placement.

Proceedings V. 46

RECOMMENDED PRACTICE FOR THE APPLICATION OF PORTLAND CEMENT PAINT TO CONCRETE SURFACES (ACI 616-49) 46-1

COMMITTEE 616—Sept. 1949, pp. 1-16 (V. 46)

Supersedes 45-18

This ACI standard establishes recommended practices for appropriate usage, age of concrete, preparation of surface, and the preparation, application, and curing of portland cement paint. Three appendixes discuss composition, manufacture and storage, and general characteristics and factors affecting durability.

AN ULTRASONIC METHOD OF STUDYING DETERIORATION AND CRACKING IN CONCRETE STRUCTURES 46-2

J. R. LESLIE and W. J. CHEESMAN—Sept. 1949, pp. 17-36 (V. 46)

A method and apparatus for field and laboratory testing of concrete is described. The apparatus, called the "Soniscope," was originally designed to detect internal cracks in concrete. It develops pulses of ultrasonic sound in the material and measures the velocity of their transmission through it. This pulse velocity has the unique advantage of being independent of the size or shape of the body under test. Measurements can be made with equal facility in mass concrete, slabs, or laboratory specimens.

The existence and extent of internal cracks and the depth of visible surface cracks can be determined by the use of this apparatus.

The velocity has been found, by experiment, to be a reliable measure of the condition of the concrete and is particularly useful in deterioration studies. The dynamic modulus can be calculated from this velocity, and values so obtained are found to agree closely with the results of tests using established methods.

MANUFACTURE OF REINFORCED FOAM CONCRETE ROOF SLABS 46-3

I. T. KOUDRIASHOFF — Sept. 1949, pp. 37-48 (V. 46)

The Russian type of lightweight concrete described used a rosin-glue emulsion to preserve the air voids before the initial set of the cement. Shrinkage was decreased and strength increased through high-pressure steam curing. The autoclave treated foam concrete used in the production of precast industrial roof slabs had a unit weight of 47 lb per cu ft and a compressive strength of over 500 psi. The lightweight slabs, used in a load carrying capacity and as insulation, reduced construction time by 50 percent and costs by as much as 20 percent. Test data on roof slabs and production procedures are also described.

SUGGESTIONS ON CONCRETE FLOOR CONSTRUCTION 46-4

ERNST GRUENWALD — Sept. 1949, pp. 49-56 (V. 46)

The relationship between good concrete floors and the proper selection of cement and aggregates is discussed. Data are cited to emphasize the advantage of coarse-aggregate mixes over cement-sand topping for concrete floors.

USE OF AIR-ENTRAINING CONCRETE IN CANAL LINING 46-5

JOSEPH J. WADDELL — Sept. 1949, pp. 57-64 (V. 46)

Presents a discussion based on field observations of the use of air entrainment in canal lining concrete. The Bureau of Reclamation made studies of air-entraining agents for use in the irrigation canal lining for the Friant-Kern Canal on the Bureau's Central Valley Project in California. Results to date indicate that appreciable benefits accrue when an air-entraining agent is used in concrete which is placed and compacted by a mechanical slip-form. Care is necessary in adjusting concrete mixes to incorporate entrained air because of the sensitivity to mix changes of concrete for slip-form placement.

THE USE OF PORTLAND-POZZOLAN CEMENT BY THE BUREAU OF RECLAMATION 46-6

ROBERT F. BLANKS — Oct. 1949, pp. 89-108 (V. 46)

The Bureau of Reclamation has made extensive studies of pozzolanic materials, and portland-pozzolan cements are now being used in many of the major structures built by the Bureau. The properties of portland-pozzolan cement that are used advantageously in the production of mass concrete are described.

RESISTANCE OF CONCRETE AND PROTECTIVE COATINGS TO FORCES OF CAVITATION 46-7

WALTER H. PRICE and GEORGE B. WALLACE — Oct. 1949, pp. 109-120 (V. 46)

A machine used for producing cavitation erosion in the laboratory is described and the results of tests made to investigate the effect of mix proportions, surface treatment, and protective coatings on the resistance of concrete to cavitation are discussed. Through proper use of these, the resistance of concrete surfaces to cavitation erosion may be extended three or four times, but even the best concrete will not resist the forces of cavitation for a prolonged period. Heavy rubber coatings bonded well to the surface of the concrete have proved effective.

VACUUM PROCESSES APPLIED TO PRECAST CONCRETE HOUSES 46-8

K. P. BILLNER and BERT M. THORUD — Oct. 1949, pp. 121-128 (V. 46)

The use of vacuum processes in precast concrete construction simplifies the building of fire-resistant, durable structures designed to permit the maximum use of like units. Vacuum processes have thus far been used in one- and two-story houses and one-story industrial or warehouse structures, but further developments should make possible similar benefits for multistory construction.

The specific vacuum methods used are: (1) extracting excess water from freshly placed concrete prior to set, thereby increasing early strength and enabling early handling of units, (2) holding forms in place by vacuum, and (3) handling and placing finished and hardened concrete units by cast-in-place closures formed and quickly hardened by vacuum processes.

The use of these methods results in high-strength, monolithic construction having exterior and interior finished surfaces, with insulation incorporated into the constructon, if desired.

NEW TYPE OF CONSISTENCY METER TESTED AT ALLATOONA DAM 46-9

JAMES M. POLATTY — Oct. 1949, pp. 129-136 (V. 46)

Various mechanical devices have been developed for indicating consistency of concrete since the early days of visual inspection after discharge from the mixer. A new type meter to measure the consistency of concrete while it is being mixed was tested at Allatoona Dam and the operation and results are described.

EFFECT OF MIXING SEQUENCE ON THE PROPERTIES OF CONCRETE ...46-10

F. L. FITZPATRICK and W. SERKIN — Oct. 1949, pp. 137-140 (V. 46)

The order in which the constituents of concrete (aggregates, cement and water) are combined in the mixing operation, has a significant effect on the properties of the concrete as to workability, strength, density, surface finish and absorption. Tests are reported.

BOND OF CONCRETE REINFORCING BARS 46-11

ARTHUR P. CLARK — Nov. 1949, pp. 161-184 (V. 46)

The tests reported were made to compare the resistance to slip in concrete (bond) of deformed bars when tested in beams and companion pull-out specimens, to secure information on the effects of size of bar, the type of deformations on the bars and the strength of concrete on the bond. The bars were cast in a horizontal position in all test specimens. The variables were depth of concrete under the bar, length of embedment of the bar in the concrete, strength of concrete and diameter of bar. Slip of the bar was measured at the loaded and free ends. Three tests were made with 2 in. of concrete under the bar, with 15 in. of concrete under the bar and with 3-in., 12-in., and 16-in. embedments.

Bond strengths for the beams and the pull-out specimens were affected similarly by changes in the geometry of the bars and the bond test specimens. They were greater when the bars were near the bottom than when they were near the top of the specimens. The highest bond strengths were obtained with bars having deformations conforming to suggested requirements for maximum spacing and minimum height and providing ratios of shearing to bearing areas less than 10, usually less than 6.

PERLITE AGGREGATE: ITS PROPERTIES AND USES 46-12

J. JOHN BROUK — Nov. 1949, pp. 185-192 (V. 46)

Synthetic expanded volcanic rock, better known as perlite is a fairly recent addition to the lightweight aggregate field. Its use in concrete is governed by weight, gradation, mixing procedure, cellular structure, strength of cell walls, insulating properties, cost, etc. Air entrainment appears to be necessary to

give a workable, nonsegregating mix. Perlite aggregate blended with sand can be used in high-strength structural concrete and concrete products.

THIN WALL CONCRETE SHIP CONSTRUCTION 46-13

FRANCIS R. MAC LEAY — Nov. 1949, pp. 193-204 (V. 46)

The development of construction methods for placing thin concrete walls is described. After several attempts using the standard method of casting between double forms, a new method was developed which permitted the successful construction of 3/4-in. and 1½-in. concrete walls. Tests were also conducted to determine the practicability as well as the strength of shotcrete as a medium to unite precast units into a monolithic ship. Later these methods were used successfully in the construction of a concrete landing craft for the United States Navy.

SPECIFICATIONS SHOULD BE REALISTIC 46-14

HARRY F. THOMSON — Nov. 1949, pp. 205-220 (V. 46)

Specifications for concrete in moderate-sized and lesser construction frequently contain provisions which are ambiguous, conflicting in application, or do not fully recognize local materials. Most of these questionable features result from (1) inadequate information regarding the characteristics of concrete, or (2) use of ready-written specifications without revision for conditions or changes in standard requirements.

Among the features discussed are: specifying both method and result, "frozen" specifications; habitual use of "1-2-4;" multiple provisions for quality, strength without naming consistency, recognition of local materials; use of compression tests; time of placing; bin-test of cement. Numerous quotations from specifications are given, and suggestions offered for bringing the provisions in line with actual conditions.

INSPECTION AND TESTING OF MATERIALS 46-15

NICOLAAS T. F. STADTFELD — Dec. 1949, pp. 237-248 (V. 46)

Sets forth the care taken in the inspection and testing of 7 million barrels of portland cement used in 4 million cu yd of concrete of great uniformity and every indication of durability after 12 years of observation. It stresses for the concrete the importance of low water solubility, freedom from "laitance," lack of cement burns of the workers, low alkali content, and it shows above all the necessity for manufacturing control of the cement clinker. It describes how premature set of concrete was prevented. It also deals with the inspection, grading, and testing of aggregates. The Board of Water Supply specifications for aggregates are given as well as other factors used in securing good material.

FLEXURE OF CELLULAR SHELLS 46-16

F. E. WOLOSEWICK — Dec. 1949, pp. 249-256 (V. 46)

After a brief discussion of the uses of cellular shells and methods available for the solution of design problems, a sample problem is set up using the theorem of least work. From charts the moments are determined and the effect of added stiffeners is assessed.

CEMENT PERFORMANCE IN CONCRETE EXPOSED TO SULFATE SOILS 46-17

L. A. DAHL — Dec. 1949, pp. 257-272 (V. 46)

The Long-Time Study of Cement Performance in Concrete deals with the performance of portland cements in concrete under various conditions of exposure in the field. Among these conditions is exposure to sulfate soils, that is, to the so-called "alkali soils." This part of the investigation is reported in Chapter 5, in which complete data are given. The present paper describes briefly the work reported in Chapter 5 and the conclusions which have been drawn. Those readers who wish to study the results in greater detail are referred to the more complete report.

(See also 44-21, 44-26, 44-33, 44-38, 47-51, 49-52, 52-13, 54-27, and 54-59)

EARLY STRENGTH OF CONCRETE AS AFFECTED BY STEAM CURING TEMPERATURES 46-18

JOSEPH J. SHIDELER and WILBUR H. CHAMBERLIN — Dec. 1949, pp. 273-284 (V. 46)

The testing and results obtained on 990 6 x 12-in. concrete cylinders steam cured for various periods and at temperatures ranging from 100 to 200 F are discussed. Strength results are given for ages ranging from 6 hr to 28 days and strengths of companion specimens moist cured at 70 F are given whenever possible. The information presented was obtained for the Bureau of Reclamation for writing specifications covering the steam curing of precast units such as irrigation pipe.

A SHORTCUT FOR DETERMINING REINFORCEMENT IN REINFORCED CONCRETE 46-19

V. BOGVAD-CHRISTENSEN — Dec. 1949, pp. 285-292 (V. 46)

Presents a graph which gives the complete relationship between moments, thrusts, concrete dimensions, reinforcement and resulting stresses for the reinforced concrete members in question.

PRECAST UNITS FOR SHORT-SPAN BRIDGES 46-20

ROBERT C. HANCKEL — Jan. 1950, pp. 317-328 (V. 46)

Bridge replacement in Lowell, Mass., where minimum traffic interruption was necessary, led to the adoption of precast reinforced concrete units. Available mobile hoisting equipment limited the maximum weight of sections to about 12 tons which permitted small bridges to be precast as complete structures, while for larger bridges, subassemblies were precast and incorporated into the bridge by a cast-in-place deck. The precasting procedures and construction processes are described and illustrated.

INFLUENCE OF SUBGRADES AND BASES ON DESIGN OF RIGID PAVEMENTS 46-21

KENNETH B. WOODS — Jan. 1950, pp. 329-348 (V. 46)

This paper was developed from research data, published reports, and experiences gained by observing the performance of both rigid and flexible pavements — particularly as related to subgrade soil textures and the use of base courses. Structural failures of rigid pavements, caused by large concentrations of exceptionally heavy loads, indicate the need for an evaluation of subgrades and bases in determining the most economical design of rigid slabs.

Indications are that the structural capacity of rigid pavements can be improved by the use of location procedures which utilize the best in topographic position and subgrade soil textures. For inferior situations — in regard to position and soils — the use of base courses must be evaluated against the economy of using slabs of increased thickness, more reinforcing steel, or combinations of the two.

It is concluded that it is not entirely feasible, with the present state of knowledge, to standardize rigid pavement design. Rather, the available data indicate that design practices should be developed by regions in which the subgrade soil, availability and type of base course materials, climatic conditions, and traffic volumes and loads are evaluated.

INSPECTION OF MASS AND RELATED CONCRETE CONSTRUCTION 46-22

LEWIS H. TUTHILL — Jan. 1950, pp. 349-360 (V. 46)

Points out that inspection of any kind can be no more effective than that permitted by the specifications and, particularly, by the established job standard of inspection. No distinctions made between the usual activities of inspection and those associated with concrete control since both have the same objective: a serviceable and presentable structure. Details of requirements and procedure to this end are discussed.

EXPERIMENTAL GROUTING INVESTIGATION FOR CHIEF JOSEPH DAM 46-23

J. M. WELLS — Jan. 1950, pp. 361-376 (V. 46)

Describes the development of a method for the control of seepage into the excavation areas of the right abutment, and through the right abutment, at the Chief Joseph Dam project on the upper Columbia River in the state of Washington.

Laboratory studies are presented on various types of grout mixtures, as well as techniques and procedures for drilling in coarse gravel by jetting methods, procedure for grouting pervious gravels, and the efficacy of grouting treatment.

USE OF POZZOLANS IN CONCRETE 46-24

RAYMOND E. DAVIS — Jan. 1950, pp. 377-384 (V. 46)

After stating the characteristics of pozzolonic materials, the effects of replacing with pozzolans part of the portland cement in concrete are considered briefly. Results of tests with fly ash and superfine diatomite are cited to show the possible use of these materials in the East and Midwest where natural pozzolans of the West are not economically available.

CONSTRUCTION OF LONG-SPAN CONCRETE ARCH HANGAR AT LIMESTONE AIR FORCE BASE 46-25

JOHN E. ALLEN — Feb. 1950, pp. 405-416 (V. 46)

The reinforced concrete arch hangar at Limestone Air Force Base is noteworthy for its size, being one of the largest of this type yet constructed in this country. The superstructure is composed of a thin reinforced arch shell, shaped like an inverted catenary. Construction procedures are described.

VOLUME CHANGES IN SMALL CONCRETE CYLINDERS DURING FREEZING AND THAWING 46-26

RUDOLPH C. VALORE, JR. — Feb. 1950, pp. 417-436 (V. 46)

The volume-temperature behavior of small concrete cylinders was observed, using a new mercury-displacement dilatometer, during freezing and thawing cycles in which the range 40 to -20 F was traversed at various rates. Specimens cast from a mix containing 6 bags of portland cement per cu yd, plain and modified by the addition of an air-entraining agent, were tested in air-dry, vacuum-saturated, and partially saturated conditions.

Volume-temperature relationships for air-dry specimens yielded uniform thermal expansion data, but those for vacuum-saturated specimens showed departures in the form of transient expansions during freezing, and residual expansions following thawing of the order of 0.8 and 0.4 percent, respectively, a single slow cycle produced decreases in dynamic *E* exceeding 60 percent.

Much smaller departures were observed for partially saturated specimens (65 to 85 percent of vacuum-saturation) and included, in addition to transient and residual expansions, secondary effects of freezing termed "shrinkage" and relaxation phenomena. The magnitude of the transient and residual expansions appeared to depend on the rate of cooling and heating, the degree of saturation of the specimen, and, during the slow cycle, on the degree of supercooling before freezing.

INSPECTION AND CONTROL OF CONCRETE FOR HIGHWAY AND BRIDGE CONSTRUCTION 46-27

H. W. RUSSELL — Feb. 1950, pp. 437-444 (V. 46)

Inspection procedures and personnel assignments used by the Illinois Division of Highways for large, medium, and small jobs are described. The importance of assurance that materials used are adequately tested and approved before shipment, determination of proper proportions by trial mixtures, control of air entrainment, correction of batch weights and proper preparation and testing of concrete specimens are emphasized. The inspection of ready-mixed concrete supplied to small jobs poses a problem still lacking an adequate solution.

SOME APPLICATIONS OF ELECTRIC SR-4 GAGES IN REINFORCED CONCRETE RESEARCH 46-28

EIVIND HOGNESTAD and IVAN M. VIEST — Feb. 1950, pp. 445-456 (V. 46)

The writers describe some applications of SR-4 gages in reinforced concrete research at the University of Illinois. Special emphasis is given to the problems involved in waterproofing gages attached to steel which is later embedded in concrete.

THE ULTIMATE STRENGTH OF REINFORCED CONCRETE BEAMS ... 46-29

S. D. LASH and J. W. BRISON — Feb. 1950, pp. 457-472 (V. 46)

The results of tests to failure on 57 small reinforced concrete beams are presented, and it is shown that they can be explained satisfactorily on the basis of a simple plastic theory of design. Formulas are proposed for determining the moments of resistance and the critical percentages of reinforcement.

A WAY TO BETTER PAVEMENT CONCRETE 46-30

F. H. JACKSON — Mar. 1950, pp. 489-496 (V. 46)

Discusses the performance requirements of concrete pavements from the standpoint, primarily, of the quality of the concrete as a material. It is pointed out that the lack of durability of much of our present day concrete may be due to our methods of construction. The writer believes pavement durability could be significantly improved by using a scientifically proportioned mix of dry consistency, well compacted by vibration or tamping, and with close control over aggregate gradation, in place of the oversanded plastic mixtures which we now use. He does not believe that air entrainment is necessarily the final answer to the problem of surface deterioration but that we should seriously consider overhauling our entire construction practice as well as our present methods of controlling the uniformity of aggregate gradations.

Current practice in the construction of concrete pavements and airport runways in Great Britain and past practice in Germany in the construction of the autobahnen are discussed to show that the placing of harsh, dry mixtures with close control of aggregate gradations is entirely feasible from the construction standpoint.

DESIGN AND CONSTRUCTION OF A CIRCULATING WATER INTAKE 46-31

W. S. COLBY — Mar. 1950, pp. 497-508 (V. 46)

Describes the design and construction of a 250,000 gpm power plant intake. An interesting feature of the pump-well cofferdam was the reinforced concrete ring wales, which resulted in savings in operations because the interior of the cofferdam was kept clear for excavating, driving of drilled-in caissons, tremie operations, and placing of the pump-well concrete.

THE CONTRACTOR'S VIEWPOINT OF INSPECTION 46-32

DONALD C. ANDREWS and NOMER GRAY — Mar. 1950, pp. 509-512 (V. 46)

The interests of owner and contractor are compared and recommendations are made on specifications, personal qualifications of the inspector, and methods of minimizing friction with the contractor.

CORROSION PROTECTION OF THIN PRECAST CONCRETE SECTIONS 46-33

D. H. PLETTA, E. F. MASSIE, and H. S. ROBINS — Mar. 1950, pp. 513-528 (V. 46)

A new electrical resistance technique for measuring the rate of corrosion of steel reinforcing is described. The method employs a thin ribbon 0.008 x 0.25 in. as the resistance element embedded in 6 x 12 in. thin

panels, and a Kelvin bridge sensitive to 0.0001 ohm. The data plotted in dimensionless parameter form enable the half-life of concrete to be determined at a comparatively early age. The term half-life is defined as the time required for the cross-sectional area of the reinforcing to decrease by one-half its original value due to corrosion. Six mixes, three water-cement ratios, four exposure conditions, and three depths of cover were examined.

DESIGN OF HEXAGONAL BINS 46-34

PAUL ROGERS — Mar. 1950, pp. 529-540 (V. 46)

The analysis of hexagonal bins is presented with a practical example, showing the details of computations for lateral pressures, inward pull, hanging loads, diaphragm action, and the design of the walls, beams and columns.

PRECAST CONCRETE IN BRITAIN . . .46-35

P. G. BOWIE and A. R. COLLINS — Mar. 1950, pp. 541-556 (V. 46)

Precast frames for airplane hangars, garages, and farm buildings are discussed. Several systems using precast units in housing construction are described and illustrated. Prestressed precast railroad ties and transmission-line poles are mentioned briefly.

THE ZIG-ZAG COURSE OF CONCRETE PROGRESS 46-36

HERBERT J. GILKEY — Apr. 1950, pp. 573-580 (V. 46)

Retiring ACI President Gilkey emphasizes that concrete has not become more complex, but rather that as knowledge advances, usually in a zig-zag course, not a straight line, more problems and seemingly contradictory half-truths become evident.

CONCRETING ON THE OTTAWA RIVER PROJECTS OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO 46-37

A. L. MALCOLM and R. B. YOUNG — Apr. 1950, pp. 581-596 (V. 46)

Construction procedures on three Hydro-Electric Power Commission of Ontario dam projects are described including the placing of concrete in lifts up to 50 ft, material and concrete handling systems, classes of concrete, sand blending, and aggregate production, treatment of joints, concrete proportioning, winter concreting, and concrete control measures. A discussion of the merits of high lifts in mass concrete structures concludes the paper.

PROPOSED DESIGN SPECIFICATIONS FOR TWO-WAY FLOOR SLABS 46-38

N. M. NEWMARK and C. P. SIESS — Apr. 1950, pp. 597-608 (V. 46)

A new design specification for two-way concrete floor slabs is presented. It is proposed as a replacement for the methods currently contained in Section 709 of the ACI Building Code (ACI 318-47). This new specification is based on analyses of continuous rectangular slabs carrying a uniformly distributed load. Account is taken of the continuity of the slab, of the torsional stiffness of the beams, and of the deflection of the beams.

INSPECTION OF BUILDING CONSTRUCTION 46-39

LEONARD E. DUNLAP — Apr. 1950, pp. 609-612 (V. 46)

From the viewpoint of an architect, inspection on a job involving architectural and structural concrete encompasses a number of factors. Accurate plans and specifications, testing and developing the concrete mix design, proper erection of forms and placement of concrete, and systematic curing require close attention by a competent superintendent and qualified inspectors.

AUSTRALIAN AGGREGATES AND CEMENTS IN RELATION TO CEMENT-AGGREGATE REACTION . .46-40

A. R. ALDERMAN, A. J. GASKIN, R. H. JONES and H. E. VIVIAN — Apr. 1950, pp. 613-616 (V. 46)

A wide variety of Australian aggregates and cements has been examined with a view to estimating the possible incidence of expansive reaction in concrete made from these materials.

Mortar bars were observed over periods up to 2 years and the results correlated with petrographic examination of the aggregates and chemical composition of the cements. This correlation has shown that in most cases the potential reactivity can be assessed by petrographic examination but that doubtful material requires supplementary mortar tests.

SOME AUSTRALIAN STUDIES ON CEMENT-AGGREGATE REACTION IN MORTAR 46-41

H. E. VIVIAN — Apr. 1950, pp. 617-624 (V. 46)

Summarizes briefly some of the papers on cement-aggregate reaction which have been published by the Commonwealth Scientific and Industrial Research Organization in Australia. These papers deal with four aspects of mortar expansion; the change in mortar tensile strength as expansion occurs, the effects on mortar expansion of alkali mobility, of void space in the mortar, and of different storage conditions.

CARBON DIOXIDE AND THE CEMENT-AGGREGATE REACTION . .46-42

A. J. GASKIN — Apr. 1950, pp. 625-628 (V. 46)

Spotting and expansion of cement mortars due to alkali-aggregate reaction can be prevented by treatment of the set mortar with carbon dioxide. Active alkali hydroxides, produced by hydrolysis of cement particles, are thereby converted to carbonates, which are inactive in contact with most aggregates. Sufficient "protective" calcium carbonate can be produced throughout the mortar to confer permanent immunity from spotting and expansion, but no appreciable improvement in tensile strength could be obtained. Carbonated mortars were found to have a high degree of dimensional stability.

SPACING OF MOMENT BARS IN PRECAST JOISTS 46-43

F. N. MENEFEE and H. L. KINNIER — Apr. 1950, pp. 629-636 (V. 46)

Spacing of moment bars in precast reinforced concrete joists in some cases has been as small as 3/16 in. although it is probable that most manufacturers use ³⁄₈-in. shear or diagonal tension bars with corresponding spacing of moment bars.

ACI Building Code places a 1 in. minimum on spacing. Undoubtedly, the regulations were written with monolithic concrete rather than light precast joists in mind. Spacing has no particular significance if all the requirements for bond are met independently of it.

In a properly designed precast joist, theoretical computations show that bond stresses are always less in proportion to the maximum allowed than are any of the other stresses.

The tests herein reported were an attempt to determine whether the artificial reduction of bond area, up to 30 percent, had any effect on the over-all strength of the joist, and to give some indication as to whether ³⁄₈-in. spacing of moment bars introduced a controlling weakness. While test results on 14 joists, all of the same dimensions, could hardly produce conclusive evidence, the results, along with the service record of precast joists, indicate the ³⁄₈-in. spacing of moment bars, with ³⁄₈-in. maximum size aggregate and with all other requirements of the Building Code met, will give a joist which will fail otherwise than in bond, from which it appears that the present 1 in. minimum in the current Building Code should be thoroughly studied with a view toward modification for precast joists, with well anchored reinforcement — if opinion and tests justify such a change.

PROPOSED SPECIFICATIONS FOR MINIMUM BAR SPACING AND PROTECTIVE COVER IN PRECAST CONCRETE FRAMING MEMBERS ...46-44

ARSHAM AMIRIKIAN — Apr. 1950, pp. 637-640 (V. 46)

The use of relatively small size aggregates and favorable conditions for quality control make it possible to place reinforcing bars in precast concrete work at closer spacings than those specified or required in conventionally cast-in-place concrete construction. Better quality control and use of rich mixtures make it also possible to obtain corrosion protection of reinforcing with relatively thin covers. Recommendations are given for a new basis of specifying bar spacing and cover, in the form of proposed specifications applicable to precast concrete work, together with a discussion of some of the considerations justifying the suggested specifications.

THE PROBLEM OF SLAB DIMENSIONS 46-45

SUBCOMMITTEE 2, COMMITTEE 325 — Apr. 1950, pp. 641-648 (V. 46)

The dimensions of concrete pavement slabs necessary for optimum results depend on and are influenced by a great many factors, economic as well as physical. The factors and their relationship to slab dimensions discussed include strength; elastic and plastic properties; volume change, subgrades; construction conditions; and slab thickness, length, and width.

EFFECT OF ENTRAINED AIR ON BOND BETWEEN CONCRETE AND REINFORCING STEEL 46-46

EIVIND HOGNESTAD and C. P. SIESS — Apr. 1950, pp. 649-668 (V. 46)

Reports an experimental investigation of the effect of entrained air on the bond properties of the new Laclede and the Hi-Bond bars, each in ½ in. and ⅞ in. sizes. Bond properties were studied through 108 pull-out tests with a constant bar embedment of 12 diameters. Bars were cast vertically as well as horizontally, in the latter case, with 6 and 30 bar diameters depth of concrete under the bars. A 5000 psi basic concrete mix was used, with air content as a major variable.

Within the scope of these tests it was found that up to the normal air content of 4 to 5 percent the bond of all bars in all positions was reduced, in terms of percent, less than the flexural and compressive strength of the concrete. Where more than 5 percent air was entrained, however, the bond of the horizontal bars was reduced rapidly, probably due to rising air.

REPORT OF ACI COMMITTEE 208 ON BOND STRESS 46-47

COMMITTEE 208 — May 1950, pp. 677-680 (V. 46)

A brief review of committee action on bond stresses in reinforced concrete with a tabulation of recommended values for various types of reinforcing bars.

NEW-STYLE DEFORMED REINFORCING BARS 46-48

RAYMOND C. REESE — May 1950, pp. 681-688 (V. 46)

The development of reinforcing bars from the original plain round or square forms to the present improved deformed patterns is traced through the early work of Withey and Abrams down to the 1949 report of Clark's tests. Noting that ASTM has adopted a standard for deformed bars, the author emphasizes the need for revision of design specifications to take into account the characteristics of the improved bars.

EXTENT AND ACCEPTABILITY OF CRACKING IN PRECAST CONCRETE FRAMING MEMBERS 46-49

ARSHAM AMIRIKIAN — May 1950, pp. 689-692 (V. 46)

One of the important questions arising in precast reinforced concrete construction concerns the acceptability of cracked framing members. Owing to the absence of definite guides for inspection, the fabricator often is penalized by unreasonable rejections. As an aid in this matter, a proposal is made for an acceptability clause which gives practical definitions of cracks and specifies limitations for acceptability.

EXTENT OF SUSTAINED LOADING ON COMPRESSIVE STRENGTH AND MODULUS OF ELASTICITY OF CONCRETE 46-50

GEORGE W. WASHA and PAUL G. FLUCK — May 1950, pp. 693-700 (V. 46)

Presents results which show the plastic flow characteristics of hand-rodded and vibrated concrete over 10½ years. Three different cements and three different water-cement ratios were included in the test program. The effect of the 10½-year loading on the compressive strength and the modulus of elasticity is also shown.

FLY ASH AS A POZZOLAN 46-51

ROBERT F. BLANKS — May 1950, pp. 701-708 (V. 46)

Fly ash is being used in combination with portland cement in the concrete mix at Hungry Horse Dam because of the benefits derived from its use, including lower cost. The effects of the fly ash as a constituent in concrete on the workability, compressive strength, durability, permeability, heat of hydration, volume change, and counteraction of expansive reaction between aggregates and alkalies in cement are discussed briefly.

THE INSPECTOR 46-52

MILES N. CLAIR — May 1950, pp. 709-712 (V. 46)

The functions of the inspector include cooperation with the contractor in planning for good workmanship and progress, observation of construction operations and the recording of important facts relative to the work, and the enforcement of specifications and good construction practice. The qualifications for the inspector are discussed; he must be experienced, interested, be able to cooperate, be honest, and have lots of common sense.

PATENTS AND CODES RELATING TO PRESTRESSED CONCRETE 46-53

CURZON DOBELL — May 1950, pp. 713-724 (V. 46)

Based on a study of more than 100 domestic and foreign patents and on correspondence with committees of engineers in England, Switzerland, France, and Sweden, this paper gives a brief account of the more important groups of patents, a synopsis of codes in preparation in the above countries, and the problems to be overcome in drafting a prestressed code for domestic use.

PRECAST CONCRETE PANEL MULTISTORY CONSTRUCTION 46-54

THOMAS F. GILBANE — May 1950, pp. 725-732 (V. 46)

The construction procedure by which precast concrete panels were used in multistory buildings is described. Brief information is given on other structures where similar construction methods were utilized. Because of inherent economies, the author predicts wider use of precast concrete construction.

TESTS OF PRECAST REINFORCED CONCRETE JOISTS 46-55

C. D. WILLIAMS and F. BROMILOW — May 1950, pp. 733-748 (V. 46)

Tests made as part of the work of ACI Committee 711 to determine the effect of bar spacing on the strength of precast concrete joists are described. The method of quarter-point loading of commercial

joists and the results of tests of bond specimens are briefly reviewed. It is concluded that the strength of the joists is controlled by the character of the weld used to fasten the stirrups to the main steel and that the test method used indicated no correlation between effective bond area of the steel and the load carrying capacity of the joists.

COST OF LONG-SPAN CONCRETE SHELL ROOFS 46-56

CHARLES S. WHITNEY — June 1950, pp. 765-776 (V. 46)

Reinforced concrete arched shell construction is compared with other types. It is pointed out that when the use of timber, structural steel, or concrete is reasonably appropriate, assuming equal skill in design and the same design requirements, the first cost of buildings with long span roofs is ordinarily not greatly affected by the choice of material. This is especially true in the case of buildings in which the structural cost may amount to only about one-third of the total.

However, this is not necessarily true of the annual cost of the project because that is greatly modified by the length of life, and cost of maintenance, repairs, operation, and insurance, which are different for the different materials. These latter cost items are difficult to estimate in advance, but, insofar as possible, cost comparisons should be made on an annual basis rather than initial cost.

INSPECTION OF READY-MIXED CONCRETE 46-57

E. L. HOWARD — June 1950, pp. 777-784 (V. 46)

The variety of mixes produced in a ready-mixed concrete plant complicates the work of the inspector in varying the mix proportions to suit the consumer's desires. Materials handling methods, changes in brands of cements, and the means provided for measuring admixtures add to the difficulties. Aids to overcome these difficulties are discussed and a meter for measuring consistency of concrete is described.

SUMMARY OF INSPECTION PRACTICE 46-58

R. B. YOUNG and W. SCHNARR — June 1950, pp. 785-788 (V. 46)

The authors summarize the seven papers on inspection given at the 46th annual convention and published one a month in the ACI Journal from December, 1949 to June 1950.

DESIGN AND CONSTRUCTION OF JOINTS IN CONCRETE PAVEMENT SURFACES 46-59

WILLIAM VAN BREEMEN and E. A. FINNEY — June 1950, pp. 789-820 (V. 46)

With a supplement on Structural Design of Joints for Airport Pavements

THOMAS B. PRINGLE

The basic fundamental conditions involved in the design and construction of joints are discussed. Various types of joints and load transfer devices are described, as well as various forms of structural failure of joints. Recommendations are given for the design, fabrication, and installation of load-transfer devices; the construction and finishing of the concrete surrounding the joint assembly; and the sealing of joints. A supplement discusses joints for heavy-duty airport pavements.

EFFECTS OF HIGH-VELOCITY WATER ON BONNEVILLE DAM CONCRETE 46-60

R. R. CLARK — June 1950, pp. 821-840 (V. 46)

Compares the progressive erosion which has taken place in the stilling basin of Bonneville Dam with that anticipated in the design, together with the repairs that have been made and the effect on the repairs of the action of high-velocity water.

PRECAST REINFORCED CONCRETE STRUCTURES 46-61

C. D. WAILES, JR. — June 1950, pp. 841-856 (V. 46)

Several examples of the use of precast concrete in industrial, commercial, and residential structures are described. Special design considerations, manufacturing methods, erection techniques, and the inspection and testing of precast members are discussed.

PRESTRESSED CONCRETE CONSTRUCTION PROCEDURES 46-62

THOR GERMUNDSSON — June 1950, pp. 857-876 (V. 46)

In reviewing the construction procedures used in the production of prestressed concrete, the methods of prestressing are grouped under several simple classifications. A brief outline of these methods is presented, and typical prestressing procedures are described and illustrated.

Proceedings V. 47

SOME OBSERVATIONS ON THE USE OF REINFORCING STEEL IN CONCRETE PAVEMENTS 47-1

BENGT F. FRIBERG — Sept. 1950, pp. 1-16 (V. 47)

Contains a few accumulated observations from a review of literature on the evolution of reinforced concrete pavement designs, with reference to various systems of reinforcement which have seen extended use. Typical structural concrete pavement failures are described. Trends in design and reinforcement practice are shown, with special reference to recent developments. Pertinent findings of a few published pavement surveys are cited, with special attention to the 900-mile Louisiana pavement survey made in 1945. The need for performance information and additional research is stressed.

TESTS OF PAPER MOLDS FOR CONCRETE CYLINDERS 47-2

ROBERT A. BURMEISTER — Sept. 1950, pp. 17-24 (V. 47)

Concrete test cylinders cast in a new type paper mold had a compressive strength lower than that predicted for the concrete mix used. Investigation showed that cracks and mechanical injuries to the outer shell of the concrete cylinder caused by movement of the paper stock during the first 24 hr of curing reduced the strength of the cylinder. To a lesser degree this was true also of the paraffined paper molds in common use for casting test cylinders; specimens cast in both types of paper molds showing lower strengths than test cylinders from the same mix cast in steel molds.

ADMIXTURES IN CONCRETE 47-3

W. T. MORAN, F. H. JACKSON, BRUCE E. FOSTER, and T. C. POWERS — Sept. 1950, pp. 25-52 (V. 47)

Five papers by members of ACI Committee 212, Admixtures, are, because of their common general subject, presented together.

Various admixtures are discussed briefly as an introduction to more detailed treatment of air-entraining materials. The relative merits of admixtures and interground agents are considered. Optimum ranges of air content for different structural uses are given with particular reference to pavements.

The advantages and disadvantages of several types of admixtures used in the fabrication of various concrete products, such as building block, cast stone, pipe, cribbing, and curbing, are discussed. The admixtures considered are classified into the following groups: accelerators, air-entraining agents, gas-forming agents, water repellent agents, and workability agents.

The factors affecting bleeding characteristics and workability of fresh concrete are reviewed and the effect of admixtures on these properties is assessed.

Present knowledge of admixtures in counteracting alkali-aggregate reactions is reviewed. It is emphasized that further studies may revise thinking in this field.

The effectiveness of various concrete admixtures in inhibiting the capillary flow of water and the flow

of water under pressure is considered. The types of admixtures included in the discussion are accelerators, soaps, butyl stearate, finely subdivided dry materials, mineral oil, workability agents, and a miscellaneous group of proprietary compounds.

IMPROVED SONIC APPARATUS FOR DETERMINING THE DYNAMIC MODULUS OF CONCRETE SPECIMENS 47-4

C. E. GOODELL — Sept. 1950, pp. 53-60 (V. 47)

After a brief introduction to sonic testing and a description of commercial equipment, the apparatus built for the Michigan State Highway Department is discussed. Reliable results can be obtained by an unskilled worker with this compact equipment which has twice the frequency band spread of the usual oscillator. A wiring diagram of the sonic apparatus is included.

ANALYSIS OF THREE-DIMENSIONAL BEAM-AND-GIRDER FRAMING 47-5

PHIL M. FERGUSON — Sept. 1950, pp. 61-72 (V. 47)

The beam-and-girder floor with some beams carried directly by columns and others supported on girders is cited as a practical problem in frame analysis that must include the torsional stiffness of the girder. Curves showing how moment coefficients vary with this torsional stiffness are developed for a few simple cases in interior panels. These show the weakness of the rule-of-thumb methods.

A practical calculation form is set up for use with the moment distribution method in solving three-dimensional problems of this type.

PROPOSED REVISION OF SPECIFICATIONS FOR CONCRETE PAVEMENTS AND BASES (617-44) .. 47-6

COMMITTEE 617 — Oct. 1950, pp. 93-116 (V. 47)

Superseded by 47-49

New specifications incorporated include those covering air entrainment, removal of forms, premolded joint fillers, and joint filling materials, and method of placing reinforcement. Definitions have been added under soil foundation preparation and other parts of this section have been revised.

LINEAR TRAVERSE TECHNIQUE FOR MEASUREMENT OF AIR IN HARDENED CONCRETE 47-7

L. S. BROWN and C. U. PIERSON — Oct. 1950, pp. 117-124 (V. 47)

The method described for the determination of air in hardened concrete permits the examination of 6 x 8-in. and 6 x 10-in. random plane face-ground hardened concrete specimens which more truly represent the aggregate and air voids in the actual concrete than smaller specimens. The construction and use of the instruments are discussed and results of tests are given. Because of the time and equipment necessary to measure air content by the integrator, it is not adaptable to field use. However, as a laboratory tool it provides a means for quick and accurate determination of total air.

INFLUENCE OF THE QUALITY OF MORTAR AND CONCRETE UPON CORROSION OF REINFORCEMENT .. 47-8

RACHEL FRIEDLAND — Oct. 1950, pp. 125-140 (V. 47)

In tests to determine the influence of the quality of mortar and concrete on corrosion of reinforcement the variables studied were cement content, water-cement ratio, consistency, grading, and depth of cover. The specimens, stored in moist air or exposed to weather, were tested up to the age of 2 years.

The results indicate that consistency has a pronounced effect on the protective value of mortar and concrete; and that there appears to exist an "optimum consistency" at which the quantity of rust is practically unaffected by time. It was also found that the usual cement contents in reinforced concrete have only a limited effect on corrosion. It is concluded that water-cement ratio does not in itself control the rate of corrosion of reinforcement.

PROPER SAND GRADING IMPROVES MASS CONCRETE 47-9

THOMAS B. KENNEDY — Oct. 1950, pp. 141-152 (V. 47)

Two series of concrete mixtures were designed using 6-in. traprock coarse aggregate and eight separate gradings of natural sand ranging in fineness modulus from 3.60 to 1.35. Tests were made of the plastic concrete, and specimens were cast for tests of compressive strength, resistance to freezing and thawing, and drying shrinkage. Both series of concrete mixtures had a cement content of 2.5 bags per cu yd; one had a normal air content, $4\frac{1}{2} \pm 1\frac{1}{2}$ percent in the portion of the mixture passing the $1\frac{1}{2}$-in sieve, and the other had a high air content, 10 ± 2 percent in the portion of the mixture passing the $1\frac{1}{2}$-in. sieve. Tests indicate that good durability in freezing and thawing can be obtained within the normal air content range with fineness modulus between 2.50 and 2.90. With increased air content, however, the fineness modulus range can be increased to extend from 1.58 to 3.24. Compressive strength was generally affected adversely by increased air content, but not to a serious degree. Drying shrinkage was less with normal air content mixes than with high air content mixtures. It was least when a fineness modulus of 2.52 was used, little difference being apparent between the high and normal air content mixes with this fineness modulus. The air-entraining admixture requirement increased greatly as the fineness modulus of the sand decreased. The water ratio also tended to increase with decreasing fineness modulus.

WATER-SOLUBILITY OF ALKALIES IN PORTLAND CEMENT 47-10

J. L. GILLILAND and T. R. BARTLEY — Oct. 1950, pp. 153-160 (V. 47)

In an effort to show correlation of soluble alkalies with alkali-aggregate reaction, the authors hydrated a number of cements for periods up to 90 days and analyzed water extracts of the ground hydrated cement. However, the correlation with expansions of mortar bars prepared with reactive aggregate was not improved by considering water-soluble alkalies rather than total alkalies.

The rate at which the alkalies become water-soluble in hydrating cement indicates that the alkali-bearing phases in cement hydrate quite readily.

NEW PRESTRESSING METHOD UTILIZES VACUUM PROCESS 47-11

K. P. BILLNER — Oct. 1950, pp. 161-176 (V. 47)

The method outlined here was developed to simplify prestressing of concrete to make it generally adaptable to American ways of construction. It eliminates costly anchorages, uses large diameter wires (3/8-in. diameter now available on the market), instead of the customary 3/16-in. diameter wire, thus greatly reducing the number of wires required, prestresses all the wires in the building element simultaneously and simplifies forming. A simplified method of design calculations for prestressed concrete and the result of tests of a beam so designed are included.

PROPOSED RECOMMENDED PRACTICE FOR THE APPLICATION OF MORTAR BY PNEUMATIC PRESSURE 47-12

COMMITTEE 805 — Nov. 1950, pp. 185-196 (V. 47)

Superseded by 47-48

This proposed ACI Standard presents briefly the advantages and disadvantages of pneumatically-placed mortar and establishes recommended practices for placing and mixing shotcrete, qualifications and duties of workmen, preparation of surface before shotcreting, reinforcing, sequence of application, and other items involved in good shotcreting.

DETERMINING OPTIMUM CROSS SECTIONS FOR PRESTRESSED CONCRETE GIRDERS 47-13

FRED J. UZIEL — Nov. 1950, pp. 197-212 (V. 47)

General solutions are presented for selecting economically optimum cross sections for prestressed concrete flexural members. Such a solution for simply supported girders of rectangular cross section, for any span and load, assuming the wires prestressed after setting of the concrete and full dead weight to act during the prestressing operation, leads to a design procedure which, in the case considered, is extremely simple and rapid to apply. It also permits comparisons and studies related to the critical cross section to be made in a more general and conclusive manner. For cross sections other than rectangular, the number of variables making the solution more indeterminate in nature, a similar direct solution is not obtainable. However, a rapid way of obtaining the minimum areas of concrete and steel required is suggested.

STEAM CURING PROTECTS WINTER CONCRETING 47-14

C. O. CRANE — Nov. 1950, pp. 213-216 (V. 47)

The use of live steam for protecting newly placed concrete from freezing weather and for providing initial curing has resulted in excellent concrete in the Enders Dam spillway at no greater cost than less desirable dry heating methods. This brief paper describes in detail the methods used.

ANALYSIS OF CONTINUOUS CIRCULAR CURVED BEAMS 47-15

BECLA VELUTINI — Nov. 1950, pp. 217-228 (V. 47)

Continuous circular curved beams can be analyzed easily by the moment distribution method if both bending and torsional end couples are considered. Formulas and tables are presented for circular curved beams of constant cross section that give the relations between the end moments and end torques and the corresponding rotations of the end sections. A proposed method of procedure is illustrated in which the bending end couples are kept separate from the torsional couples. The mathematical operations are not difficult as the convergence is rapid, but attention must be paid to the sign convention which must be definite and easy to apply.

SHEAR RESISTANCE OF TILE-CONCRETE FLOOR JOISTS 47-16

J. NEILS THOMPSON and PHIL M. FERGUSON — Nov. 1950, pp. 229-236 (V. 47)

Tests on certain types of tile-concrete joists indicate that the tile webs are more effective in resisting diagonal tension than is indicated by the current ACI Building Code specification. Stagger of tile joints appears to be unnecessary, since they do not seem to be planes of weakness insofar as diagonal tension is concerned. The tile reduces the deflection of the joist.

SOLUTION OF DIFFICULT STRUCTURAL PROBLEMS BY FINITE DIFFERENCES 47-17

ALFRED PARME — Nov. 1950, pp. 237-256 (V. 47)

Finite differences can be applied to the solution of those structural problems in which the physical relationships are expressed as a differential equation. Essentially, the technique employed consists of replacing the derivatives of the differential equation by its central difference equivalent. The problem is thus reduced to the simple task of solving a system of simultaneous linear algebraic equations. The numerical computation involved in the procedure is considerably reduced by two devices. First, the number of equations necessary to attain sufficient accuracy is reduced by an evaluation of the error introduced in substituting central differences for derivatives. Secondly, the solution of simultaneous equations is speeded by a systematic rapid tabulation of easily determined values. The procedure is applied to the design of a sheet pile wall, elliptical dome and skewed bridge to illustrate the scope and simplicity of the method.

PROPOSED REVISION OF BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-47) 47-18

COMMITTEE 318 — Dec. 1950, pp. 269-276 (V. 47)

Superseded by 47-43

Proposed changes decrease the allowable bond stress in plain bars (including the old types of deformed bars) and increase the allowable bond stresses for the new types of bars over those previously allowed for the old types. Top bars, those having more than 12 in. of concrete under them, are assigned lower bond stresses than bars in other positions. All plain bars must be hooked, which corresponds to special anchorage under the old provisions. The new bars develop sufficient anchorage by bond alone to correspond to special anchorage with the old type bars. Consequently, all bars under the new provisions correspond to those with special anchorage under the old provisions.

CURING CONCRETE PAVEMENTS WITH MEMBRANES 47-19

C. C. RHODES — Dec. 1950, pp. 277-296 (V. 47)

To provide data to assess the advisability of continuing membrane curing of concrete pavements as an alternate method, laboratory and field tests were made to compare the effect of storage conditions on the physical properties of concrete, warping, temperature control, and strength, and abrasion resistance of concrete cured with membranes and with wet burlap. A survey of pavements cured with clear membranes in spring and summer showed that cracking, when it occurred at all, was found predominantly in pavements laid in the morning hours. Comparing white-pigmented membranes with the usual wet-curing conditions in the field it was found to be efficient, practicable and about half as expensive as wet curing under the same conditions.

BLADE CHANGES IMPROVE TILTING MIXER 47-20

GLENWAY MAXON — Dec. 1950, pp. 297-300 (V. 47)

Recent experiments, as well as earlier studies, on changing the blading of tilting concrete mixers so as to improve the quality of the mixed concrete are described. The evolution of the blade shapes and the effect of these changes on the path of the materials through the mixer are illustrated.

PROTOTYPE PRESTRESSED BEAM JUSTIFIES WALNUT LANE BRIDGE DESIGN 47-21

GUSTAVE MAGNEL — Dec. 1950, pp. 301-316 (V. 47)

The tests made on a prestressed concrete beam of 154 ft 8 in. span, identical to the beams of the main span of the Walnut Lane Bridge in Philadelphia, more than justified the adoption of prestressed concrete for the bridge. The test methods and results are described. The test beam exhibited a safety factor against cracking of about 2, which would be far lower for a reinforced concrete beam. The factor of safety against complete failure was about the same as for reinforced concrete while the deflection was less. It is possible to use prestressed concrete for beams where structural steel can not be used due to excessive deflection. The tests proved that the Walnut Lane Bridge will have an exceptional degree of safety with less weight and greater durability than would be possible with reinforced concrete, as well as being considerably cheaper than the conventional solution.

FINISHING AND CURING: A KEY TO DURABLE CONCRETE SURFACES....47-22

MYRON A. SWAYZE — Dec. 1950, pp. 317-332 (V. 47)

After a comparison of past and present pavement curing and finishing techniques the significance of timing and character of finishing and the timing

and mode of curing are discussed. Laboratory tests are cited to show the effect of time of finishing and curing on surface durability to freezing and thawing. It is recommended that all concrete exposed to frost contain entrained air, have a low water-cement ratio and be thoroughly compacted after placing. A finishing and curing procedure is suggested which is adapted to the ambient conditions and to the hydration needs of the cement.

ECONOMY THROUGH BETTER CONTROL OF REINFORCING STEEL 47-23

F. TESSITOR and P. ROSEWARNE — Dec. 1950, pp. 333-340 (V. 47)

Difficulties and troubles encountered through the use of reinforcement steels not in strict accordance with present-day specifications are discussed. Data are presented to show the possibility of alleviating the situation for engineers, producers and contractors. Simplification of materials requirements, liberalization of code requirements to permit hot bending of bars and permanent identification of grade of steel would, in large measure, permit designers to apply reinforcement to structures in a more effective manner.

PROPOSED REVISION OF MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES (ACI 315-48) 47-24

COMMITTEE 315 — Jan. 1951, pp. 349-352 (V. 47)

Superseded by ACI 315-51

Changes are proposed in bar designations to conform to the numbered designation of the U.S. Department of Commerce and in all drawings to agree with new bond values and anchorage details for new-style deformed bars. Editorial changes in the text of the Standard are outlined. This is an announcement only of changes to this separate ACI publication.

COARSE-GROUND CEMENT MAKES MORE DURABLE CONCRETE 47-25

HAROLD W. BREWER and RICHARD W. BURROWS — Jan. 1951, pp. 353-360 (V. 47)

A test procedure for mortar ring specimens is described. Rings containing coarse-ground cement shrunk less and showed greater resistance to freezing and thawing and to outdoor exposure than those containing fine-ground cement. These laboratory tests indicate that coarse-ground cement produces more durable concrete than fine-ground cement.

SIMPLE EQUIPMENT ECONOMICALLY EXPLORES PRESTRESSING 47-26

MARVIN L. MASS and JACK R. JANNEY — Jan. 1951, pp. 361-364 (V. 47)

A tubular grip using type metal to hold the prestressing wires is described. Other equipment includes a framework against which the prestressing force is applied and adjustable formwork for experimental beams. The equipment is so simple that it can be easily and inexpensively built to permit study of prestressed reinforced concrete in the small laboratory.

LABORATORY TESTS OF SPACED AND TIED REINFORCING BARS 47-27

WILLIAM T. WALKER — Jan. 1951, pp. 365-372 (V. 47)

Tests of beam and pull-out specimens containing spaced and tied reinforcing arrangements indicated that little or no advantage would be obtained by spacing deformed reinforcing bars at splices. Pull-out tests showed that for deformed bars, placed vertically, in which interlocking of lugs could take place there was a slight increase in strength due to tying the bars. Beam tests showed no significant difference between spacing and tying.

Twelve beams containing three different types of deformed bars either spaced or tied and extending the entire length of the specimens were tested. The sixty vertical pull-outs tested also contained three different types of deformed bars. Half of these were made with the bars spaced and half with the bars tied together. The reinforcing arrangement brought only one bar out of the specimens for pulling, the other was allowed to bear on the base plate.

Spacing of the bars in both beams and pull-outs conformed to the joint code minimum spacing requirement of 2½ diameters center to center with a minimum clear distance of 1½ times the maximum size of coarse aggregate.

FINISHING AIR-ENTRAINING CONCRETE PAVEMENTS 47-28

CHARLES W. ALLEN — Jan. 1951, pp. 373-376 (V. 47)

Based on a survey of state highway department practices, common difficulties in finishing air-entrained concrete pavements are enumerated. Practices in adjusting transverse finishing machines are given and revised finishing practices are discussed. Delayed finishing, as specified in several states, is considered in connection with the riding qualities of the finished surfaces. On the basis of experience in Ohio it is concluded that smooth pavements can be built of air-entrained concrete without delayed finishing.

EFFECTS OF LATERAL LOADS ON ARCHES 47-29

JAMES P. MICHALOS — Jan. 1951, pp. 377-388 (V. 47)

The effects of lateral loads on arches and the possible magnitude of these effects are considered. An influence table and influence lines are presented for moments and shears in unbraced parabolic arch ribs of constant cross section. These values are for several ratios of rise to span and several ratios of bending to torsional stiffness. The effect of haunching is studied and its possible importance is assessed. Procedures are presented for drawing approximate and exact curves of moments for unbraced arch ribs and for arch ribs braced with struts normal to the ribs. Numerical studies are included.

GETTING MORE FOR OUR CONCRETE DOLLAR 47-30

I. E. MORRIS — Jan. 1951, pp. 389-396 (V. 47)

A concrete slab with alternating horizontal elements connected by sloping elements is described and its design is worked out. The system is intended primarily for roofs where an exposed ceiling is desired for economy. It may be used to span considerable distances, either as a simple span or as a series of continuous spans. The members are designed to use both concrete and steel to maximum advantage.

FACTORS INFLUENCING CONCRETE STRENGTH 47-31

WALTER H. PRICE — Feb. 1951, pp. 417-432 (V. 47)

The effect of mix proportions, type and brand of cement, availability of moisture for curing, accelerators, and curing temperatures on the rate and potential strength development of concrete are discussed. The influence of rate and frequency of load applications, dimensions of test specimens and lateral restraint on the indicated strength are also discussed, and information is furnished on the variations in strength which might be expected on a typical job. Compressive, tensile, flexural, bond and shearing strengths are compared, and the strengths of control cylinders are compared with the strengths of cores drilled from structures at later ages. Information is also furnished on strength loss from freezing and thawing and alkali-aggregate expansion.

SONISCOPE TESTS CONCRETE STRUCTURES 47-32

E. A. WHITEHURST — Feb. 1951, pp. 433-444 (V. 47)

The Soniscope, an instrument which measures group velocities through as much as 50 ft of concrete, was used for the field testing of 13 bridges, one navigation lock, 14 dams, and five highway pavements in 12 states. Repeated tests permitted study of changes in the condition of the concrete and the development of group velocities indicating the condition of the structure. The value of the results in-

creases with knowledge of the materials, mix proportions, method of placement, and other characteristics of the structure being tested.

EFFECTIVE SEALING OF CONCRETE PAVEMENT JOINTS 47-33

H. F. CLEMMER — Feb. 1951, pp. 445-448 (V. 47)

The development of cork, metal, and rubber joint sealers is traced and work with thermoplastic and cold-pour joint filling compounds is described. The importance of proper technique of preparing and placing the newer materials is emphasized.

ENTRAINED AIR SIMPLIFIES WINTER CURING 47-34

JOSEPH J. SHIDELER, HAROLD W. BREWER, and WILBUR H. CHAMBERLIN — Feb. 1951, pp. 449-460 (V. 47)

The investigation described was undertaken to determine the winter protection required to protect air-entrained concrete from damage by freezing. Cylinders made with Types II and V cement and various percentages of calcium chloride were cured at temperatures ranging from 10 to 70 F and tested for strength at ages ranging from 3 to 180 days. The resistance of these concretes to accelerated freezing and thawing was compared. The results indicate that the amount of winter protection, as presently specified by the Bureau of Reclamation, can be reduced when air-entrained concrete is used.

PRECAST CONCRETE CONSTRUCTION IN CANADA 47-35

OTTO SAFIR — Feb. 1951, pp. 461-468 (V. 47)

Precast concrete construction techniques as applied to a warehouse, parking garage, and retaining wall project are described. Beams and columns for the precast concrete frames of a warehouse were cast flat in multiple forms on the ground slab. Cold weather required special precautions in mixing, placing, and curing the concrete. In a parking garage, precast elements were combined with cast-in-place members to form an essentially monolithic structure. A retaining wall 25 ft high is of precast counterforts and 8-in. wall planks. Principal features of the job were the complicated shape of the counterforts and the weight of the completed units.

FACTORS IN PRESTRESSED GIRDER DESIGN 47-36

M. FORNEROD — Feb. 1951, pp. 469-480 (V. 47)

Following a general description of the Walnut Lane Bridge the stages of loading of the prestressed concrete girders and the sequence of construction operations as they affected the design are discussed. The owner's stress limitations are listed and longitudinal bending in girders, transverse bending in stiffener diaphragms, and shear and principal tensile stress in the girder are considered. Safety factors are considered for various loading conditions.

PRECAST CONCRETE OFFERS PROTECTION AGAINST ATOMIC BLAST 47-37

ARSHAM AMIRIKIAN — Mar. 1951, pp. 497-516 (V. 47)

Precast concrete is an excellent means for providing protection against atomic blast. The technique is suitable for new construction and is adaptable to existing structures by providing them with a protective shell. Readily-assembled framing elements can be prefabricated at regional plants and stored or stockpiled at various points for immediate use in an emergency.

For design purposes, in this paper, shelters are divided into three groups in relation to their proximity to a probable target. Suggested arrangements and main details of assembly of a number of types of precast framing suitable for each group are presented. A general discussion of the protection problem, the needed weapons data and design criteria are also given.

FALSE SET IN PORTLAND CEMENT 47-38

R. F. BLANKS and J. L. GILLILAND — Mar. 1951, pp. 517-532 (V. 47)

False set of cement causes difficulties in mixing and placing and even though the stiffening is eliminated by job conditions, extra mixing or the addition of corrective admixtures, undesirable effects on the hardened concrete remain. It adversely affects water requirement, strength, bond between aggregate and matrix, brittleness and cracking, resistance to freezing and thawing, and air-entraining characteristics.

Correctives in the manufacture of the cement are proper cooling of mills or the use of stable calcium sulfate.

DIRECT DESIGN OF T-BEAMS 47-39

HENRY J. COWAN — Mar. 1951, pp. 533-544 (V. 47)

In designing T-beams by usual methods some initial dimensions of the section must be assumed, either the complete dimensions — and the maximum concrete and steel stresses computed to ensure they are less than the allowable stress — or the effective depth only assumed — with tension area computed and the maximum compressive stress in the flange checked to find if compressive reinforcement is required. The author emphasizes that both methods are likely to produce uneconomical sections and take more time.

The direct design procedure proposed enables the dimensions of a T-beam to be calculated for any given set of conditions. Curves are set up for finding the value of *j*, and the solution of problems by normal methods and "direct design" are compared by solving six examples. An "equivalent flange" method is proposed for the balanced design of T-beams when the area of compression reinforcement is specified and results show little difference between exact and approximate methods of design.

ALKALI-AGGREGATE EXPANSION CORRECTED WITH PORTLAND-SLAG CEMENT 47-40

FEDERICO BARONA DE LA O — Mar. 1951, pp. 545-552 (V. 47)

Rather than a pozzolan, granulated basic blast furnace slag described in ASTM C 205 should be considered a latent or potential cement with a high siliceous glass content that requires the presence of hydrated lime and gypsum to hydrate properly. To correct alkali-aggregate expansion, a high proportion of slag (about 50 to 60 percent) should be used, which does not reduce strength, rather than lower percentages (20 to 30) which can not be exceeded with pozzolans unless strength is sacrificed. The portland-blast furnace slag cement produced in Mexico, meets ASTM requirements, presents satisfactory strength, low heat of hydration, and low alkali content. The corrective action was investigated using Pyrex glass as reactive aggregate, and NaOH to increase the alkali content of the different cements and blends to the same high value (1.23 percent).

Under similar conditons, with the same high alkali content, much smaller expansions were obtained with slag blends than with straight portlands. It is not intended to compare or recommend the use of slag instead of pozzolans, or the use of portland-blast furnace slag cement instead of modified, low-heat, or sulfate resistant portland cement, since in each case, the availability, cost, and special conditions will determine what to use. In many cases, slag can be used advantageously to replace 50 to 60 percent of portland clinker.

LEAN MASS CONCRETE USED FOR INTERIOR OF DAMS 47-41

BYRAM W. STEELE — Mar. 1951, pp. 553-560 (V. 47)

It is not necessary for concrete in the interior and exterior of a dam to have equal durability. By placing 4-bag concrete on exterior faces and lean mass concrete (2½-bag mix) in the interior, it is possible to achieve both durability and economy in gravity dam construction. Lean mass concrete is important in minimizing volume-change cracking; the ensuing

economy is an additional feature. The use of interior and exterior mixes in Corps of Engineers dams is described.

ACI'S PLACE IN A BILLION DOLLAR INDUSTRY 47-42

FRANK H. JACKSON — Apr. 1951, pp. 581-588 (V. 47)

Retiring ACI President Jackson examines Institute activities in relation to the concrete construction industry. ACI has won for itself a high place among the national professional engineering societies, but that eminence cannot be held without continual vigilance and increased effort on the part of all Institute members. Three major phases of activity are examined — annual and regional meetings, publications, and committee functions. Recommendations are presented for improving and increasing Institute activities.

BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-51) 47-43

COMMITTEE 318 — Apr. 1951, pp. 589-652 (V. 47)

Supersedes 44-1 and 47-18
Superseded by 52-57

This code covers the proper design and construction of buildings of reinforced concrete. It is written in such a form that it may be incorporated verbatim or adopted by reference in a general building code, and earlier editions of it have been widely used in this manner.

Among the subjects covered are: Quality of concrete; allowable stresses; mixing, placing, curing, and cold weather protection of concrete; forms; cleaning, bending, placing, splicing, and protection of reinforcement; construction joints; general design considerations; flexural computations; shear and diagonal tension; bond and anchorage; flat slabs; columns and walls; and footings.

The quality and testing of materials used in the construction are covered by references to the appropriate ASTM standard specifications.

THIN CONCRETE TOPPING RESTORES OLD PAVEMENT 47-44

H. WALTER HUGHES — Apr. 1951, pp. 653-660 (V. 47)

Lack of information on bonding new concrete to old led to laboratory bonding tests on wet and dry surfaces. Favorable results led to experiments on topping concrete road slabs, which required special techniques in bonding, screeding, compacting and finishing. No sign of surface disintegration has been observed after 6 years on any of the sections. Results indicate that the use of low water-cement ratio, graded mixes and compaction gives ample bond for thin toppings of floors or badly scaled pavements in which the concrete is sound. Concrete pavements containing low durability aggregates can also be given durable wearing surfaces with thin high-grade toppings.

UNIT BUILDINGS CUT CONSTRUCTION COSTS..........47-45

L. G. FARRANT and W. C. HARRY — May 1951, pp. 669-680 (V. 47)

Design of a parking garage, separating the building into many parts, resulted in a highly functional and flexible low cost structure. The authors recognize that the principle of unit buildings can be applied to any type structure.

A flat slab readily adapts itself to this principle and in this design it was again proved that the methods of analysis recommended by ACI can be applied to a slab of unconventional nature to obtain adequate safe design.

PLAIN AND REINFORCED CONCRETE ARCHES 47-46

REPORT OF COMMITTEE 312 — May 1951, pp. 681-692 (V. 47)

A general method for the design of arches taking into account all important factors such as dead and live loading and the effects of volume changes, abutment movements, and arch deflections. Because of the nonlinear relation between loads and the bending moments caused by deflections, it is found necessary to use an ultimate strength method of design taking into consideration the total effect of critical loading conditions including possible overload. The method permits the proportioning of a rib for optimum stiffness under assumed conditions, thus providing the most economical and satisfactory design.

While it has been general practice to disregard the effect of arch rib deflections, it should be included in the analysis to provide a proper safety factor against buckling and failure due to bending.

NEW APPROACH TO INHIBITING ALKALI-AGGREGATE EXPANSION...47-47

W. J. McCOY and A. G. CALDWELL — May 1951, pp. 693-708 (V. 47)

Investigators have studied for a decade the chemical reactions between high-alkali cement and siliceous mineral constituents of some aggregates toward deterioration of concrete. Papers on this subject indicate a consensus that there are just two possible remedial measures when reactive aggregates are used — low-alkali cement or substitution of a pozzolanic material for 20 to 30 percent of the portland cement.

Investigative work focused off the beaten path of pozzolans and lowering cement alkali content resulted in experimental data which indicate that small amounts of certain materials added to high-alkali cement have an inhibiting effect on expansion reaction. For example, it has been found that 1 percent or less of specific salts will reduce expansion more than 75 percent in Pyrex glass mortar bar tests. This reduction was substantiated by similar mortar bar tests using a small percentage of opal and quartz sand as aggregate.

Additional information indicates that small amounts of certain proteins (0.2 percent or less) added to the cement appear to have a greater inhibiting effect on the expansive reaction than is obtained by comparable air entrainment effected by the conventional air-entraining agents. Such inhibitors appear to have no appreciable detrimental effect on the properties of the high-alkali cements as determined by ASTM specification tests for cement.

RECOMMENDED PRACTICE FOR THE APPLICATION OF MORTAR BY PNEUMATIC PRESSURE (ACI 805-51) 47-48

COMMITTEE 805 — May 1951, pp. 709-720 (V. 47)

Supersedes 47-12

This ACI Standard presents briefly the advantages and disadvantages of pneumatically-placed mortar and establishes recommended practices for placing and mixing shotcrete, qualifications and duties of workmen, preparation of surface before shotcreting, reinforcing, sequence of application, and other items involved in good shotcreting.

SPECIFICATIONS FOR CONCRETE PAVEMENTS AND BASES (ACI 617-51) 47-49

COMMITTEE 617 — May 1951, pp. 721-744 (V. 47)

Supersedes 41-27 and 47-6
Superseded by 55-3

Standard specifications for the construction of portland cement concrete pavement and base under normal conditions, including preparation of the subgrade.

The subjects covered include: materials, proportions of materials based on design for minimum strength or based on uniform cement factor, measurement and handling of materials, mixing, high-early-strength concrete, subgrade preparation, forms, installation of joints and reinforcement, placing and finishing concrete, and curing.

ARE PRESTRESSED BRIDGES CHEAPER? 47-50

STEWART MITCHELL—June 1951, pp. 761-772 (V. 47)

To study the use of prestressed concrete for highway bridges a pedestrian bridge over Arroyo Seco in Los Angeles was designed and placed under contract. In the United States, principal savings are expected to be for formwork rather than in reduction of steel and concrete. Cast-in-place and precast prestressed bridges applicable to California sites are described.

Lack of technical data, cost information, and experience restrict the use of prestressing techniques at present. Further studies and better specifications are needed to promote the use of prestressed concrete.

LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE, CHAPTER 7 — NEW YORK TEST ROAD 47-51

F. H. JACKSON and I. L. TYLER—June 1951, pp. 773-796 (V. 47)

Test procedure, materials, mix proportions, and construction procedures on the New York Test Road, a part of the Long-Time Study of Cement Performance in Concrete, are described. All 27 of the Long-Time Study cements were used in conjunction with a nontest cement for adjusting equipment and mix proportions. Performance of the test sections is assessed with respect to durability of the concrete as a material, the only property directly studied in relation to the cement used.

Seven and one-half years after the test pavement was completed no one cement proved superior to the others tested. However, the effects of air entrainment in improving resistance of the pavement to scaling and weathering overshadowed all other variables. The use of abrasives with ice control chemicals caused scaling on non-air-entraining concrete. A 2- to 3-in. increase in slump of the test concrete had no appreciable effect on the durability of the concrete.

(See also 44-21, 44-26, 44-33, 44-38, 46-17, 49-42, 52-13, 54-27, and 54-59)

SLAB WARPING AFFECTS PAVEMENT JOINT PERFORMANCE 47-52

F. N. HVEEM—June 1951, pp. 797-808 (V. 47)

An investigation of joint troubles and failure is discussed and a method of determining thermal and moisture expansion in thin concrete specimens described. Evidence of warping and curling of pavement slabs and the sequence of events leading to pumping and subsequent faulting of joints are considered. It was evident that curling was due to combined effects of temperature differential and moisture. Profilograph studies of pavement surfaces are described.

One solution to pavement failures is the elimination of expansion joints and the spacing of contraction joints as far apart as possible. No practical method is available that will prevent moisture from accumulating beneath the pavement.

IDENTIFICATION OF DEHYDRATED GYPSUM IN PORTLAND CEMENT...47-53

J. L. GILLILAND—June 1951, pp. 809-820 (V. 47)

False set in portland cement is usually attributed to dehydrated gypsum. Inasmuch as hemihydrate is much more soluble than gypsum, the concentration of sulfate ion in the liquid phase of cement pastes can be used to identify cements in which dehydrated gypsum is likely to cause trouble. The solubility test correlates with the penetration test used to detect stiffening.

While x-ray diffraction and differential thermal methods can be used to identify various forms of calcium sulfate in high concentrations, they are not applicable to the study of calcium sulfate in portland cement.

COOLING MATERIALS FOR MASS CONCRETE 47-54

H. H. ROBERTS—June 1951, pp. 821-832 (V. 47)

To maintain proper temperatures in the 1,500,000 cu yd of concrete in Detroit Dam, several techniques were considered. After an investigation of the heat balance in the materials, it was decided to construct a plant for cooling the aggregate and cement. A brief history of cooling mass concrete precedes the description of the cooling plant for Detroit Dam.

The coarse aggregate is immersed in 35 F water until the aggregate cools to 38 F. It is then drained and screened to remove excess moisture.

Sand and cement are cooled by continuous hollow-flight screw conveyors through which 35 F water is circulated. Heat transfer is through the conveyor surfaces; there is no direct contact with the cooled water.

AIR REPLACES SAND IN "NO-FINES" CONCRETE 47-55

RUDOLPH C. VALORE, JR., and WILLIAM C. GREEN—June 1951, pp. 833-848 (V. 47)

Concretes containing high-early-strength cement, 20 to 30 percent entrained air in place of fine aggregate, siliceous pea gravel and a proprietary resin or detergent air-entraining agent, were made using ordinary rotating tilt-drum mixers. The maximum air contents in mixes having a compressive strength of 500 psi (28 days) were 25 percent (3.3 bag mix) and 29 percent (5.6 bag mix). The ratio of compressive to transverse and bond strengths was about 3. The saturation coefficient and capillarity were much lower, the resistance to freezing and thawing generally higher, and the thermal conductivity (k) 30 to 40 percent lower than for a nonaerated sand-gravel concrete. The drying shrinkage was about the same as for a nonaerated concrete. The compressive strength of all mixes decreased about 100 psi for each percent increase in air content, which was difficult to control.

Proceedings V. 48

EARTHQUAKE RESISTANT DESIGN CONSIDERATIONS 48-1

R. R. MARTEL—Sept. 1951, pp. 1-4 (V. 48)

Basic behavior characteristics of earthquakes, their effects on structures and considerations for further study of design criteria.

COMPREHENSIVE NUMERICAL METHOD FOR THE ANALYSIS OF EARTHQUAKE RESISTANT STRUCTURES 48-2

CHARLES S. WHITNEY, BOYD G. ANDERSON, and MARIO G. SALVADORI—Sept. 1951, pp. 5-28 (V. 48)

A new step-by-step method for the analysis of earthquake stresses in multistory frame buildings is presented and compared with the rigorous solution of the same problem to evaluate its efficiency. The following essential factors influencing earthquake stresses are considered: (1) stiffness and internal damping of the resisting structure, (2) rocking of the foundation due to the yield of the ground, and (3) period and amplitude of the earthquake components. It is shown how the method can be extended to buildings in which stresses beyond the elastic limit create plastic hinges. Estimates of time and labor required by the proposed method are presented.

MULTISTORY BUILDINGS DESIGNED TO RESIST EARTHQUAKES..........48-3

JOHN J. GOULD—Sept. 1951, pp. 29-36 (V. 48)

Earthquake resistant provisions of the San Francisco building code were met by the exclusive use of reinforced concrete in the construction of eleven 13-story apartment buildings. The X-shaped apartments have flat-slab floors with wide flat beams over corridors. Exterior walls are of the bearing-wall type without columns. Many interior partitions are of re-

inforced concrete to resist vertical as well as horizontal loads. An advantage of the interior bearing wall system is that lateral bracing for earthquake resistance is increased at little extra cost.

It was estimated that the extra cost of earthquake resistance was only 1 to 2 percent of the total, as compared with otherwise sound minimum construction, due to the structural system chosen.

LIGHTWEIGHT CONCRETE FOR LOWER CONSTRUCTION COSTS . . . 48-4

J. A. MURLIN — Sept. 1951, pp. 37-44 (V. 48)

From accurate construction costs taken from the contractor's records on a cost plus fixed-fee contract, it is demonstrated that the use of lightweight expanded shale concrete plus flat plate design substantially reduced the cost of the structural frame of a two-story office building. Comparative figures are given for eight different types of construction in normal or lightweight concrete. The method of analysis used in designing the lightweight flat plate is discussed.

The mix proportions for the lightweight concrete are given and the plant setup for the use of mixers in series is described. Results of laboratory tests of control cylinders are shown.

DESIGNING FOR CONTINUITY IN PRESTRESSED CONCRETE STRUCTURES 48-5

ALFRED L. PARME and GEORGE H. PARIS — Sept. 1951, pp. 45-64 (V. 48)

The design of simply supported prestressed members has been well established but the design of continuous prestressed concrete structures has received little attention because of difficulty in analyzing such members. A method of analysis is developed for continuous prestressed members that reduces the problem to the same simplicity of analysis by moment distribution as for ordinary continuous reinforced concrete members.

The method is relatively simple and does not involve abstract integrations of complicated expressions. The problem of design is simplified to the extent that a physical relationship can be seen between the profile of the curved wires and the forces they exert on the structure. Because the stresses produced by these forces can be readily determined, the method of analysis offers greater flexibility in the design of continuous prestressed structures.

PUMICE — LIGHTWEIGHT AGGREGATE 48-6

LESLIE I. NEHER — Sept. 1951, pp. 65-76 (V. 48)

The growth of pumice production in the United States during recent years is worthy of note. Chemical and physical properties, mix design, presaturation of aggregates, and the application of pumice aggregates in lightweight tilt-up and masonry construction are discussed.

HYDRATION PRODUCTS FORMED IN CEMENT PASTES AT 25 TO 175 C. . 48-7

GEORGE L. KALOUSEK and MILTON ADAMS — Sept. 1951, pp. 77-92 (V. 48)

Research described indicates the chemical nature of a new potential hydration product of cements responsible for the high strength of steam cured cement products. Differential thermal analysis was used in studying hydration products of cement and related solids at temperatures between 25 and 175 C. Additions to the cement included gypsum and finely ground quartz. The trisulfate form of calcium sulfoaluminate and presumably the analogous sulfoferrate were found as the initial R_2O_3 bearing hydrates at temperatures between 25 and 100 C, but these transformed to the related solid solution of the SO_3 bearing solids. The latter then converted to phase X. At 100 C these consecutive reactions appeared to be complete in 3 to 4 hr, and increasingly longer time was required for completion as the temperature was lowered. The solid solution formed in greater abundance at about 70 to 100 C than at lower temperatures.

The hydrogarnets were not found in any sample of cement hydrated at temperatures between 25 and 175 C. Samples of pure $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ converted initially to hydrogarnets in the presence of water, but with periodic regrinding of the solids it was found that in the interval between about 3 and 6 months the initial product was transformed completely into $4CaA \cdot Al_2O_3 \cdot 13H_2O$, which probably contained some integrally bound Fe_2O_3 and a gel.

Experimentation on the synthesis of phase X indicated that this solid may be a gel consisting of all the oxide constituents of cement. Lime, silica, and ferric oxide are required constituents for the formation of this phase.

Ground silica added to the cement in an amount of about 8 to 10 percent appeared to combine with all the hydrolytic $Ca(OH)_2$ at 175 C, the reaction product being the crystalline dicalcium silicate hydrate discovered by Thorvaldson and Shelton. The total amount of this phase was estimated to be about one-third to one-half of the reaction products. Further additions of silica reacted in turn with this compound and at about 40 to 45 percent addition the new product of reaction approached in composition a $CaO:SiO_2$ molar ratio of about 1.0 and is characterized in thermal analysis by a pronounced exothermic peak at 840 ± 5 C.

ADVANCES IN PRECAST FLOOR SYSTEMS 48-8

F. N. MENEFEE — Oct. 1951, pp. 113-124 (V. 48)

Reinforced concrete floors and roofs for office and school buildings, apartments, and similarly loaded structures are being made of precast blocks assembled to form a "plank" or "slab," precast joists with a precast filler placed between, and 4-ft wide precast slabs supported by two integrally precast T-joists.

The high cost of carpentry has brought about a successful attempt to eliminate most of the previously required formwork. The trend is toward units made of high strength, lightweight aggregate under closely controlled factory conditions.

In one of the plank or slab types herein reported the steel is given a stress of approximately 18,000 psi, but it is believed that most of this prestress is lost through shrinkage and plastic flow by the time actual working loads are imposed.

Special shape block forming and grinding equipment produces blocks to be assembled into floor plank or slabs held in compressed relationship by threaded steel reinforcing rods. Precast inverted T-joist forming machinery makes joists to be used with a special shaped hollow filler block to make a floor which may be laid without formwork.

Tests show that for the most part standard reinforced concrete theory is applicable to these new floor systems. Where there is doubt as to the theory covering the new types, tests are being made under Section 103(a) ACI Building Code (318-51) and "Minimum Standard Requirements for Precast Floor Units (ACI 711-46)," resulting in widespread approval.

MANUFACTURE AND USE OF MACHINE-MADE PRECAST STRUCTURAL ELEMENTS 48-9

A. G. STREBLOW — Oct. 1951, pp. 125-132 (V. 48)

Experience with precast piles, joists, and cored roof and floor sections and the introduction of automatic block making machines suggested the development of new precast products. The characteristics and application of floor and roof slabs, wall sections, prefabricated packaged buildings, columns, beams, planks, and special structures are described.

TILT-UP CONSTRUCTION IN WESTERN UNITED STATES 48-10

F. THOMAS COLLINS — Oct. 1951, pp. 133-144 (V. 48)

Precast concrete construction is increasing rapidly in the United States. The method described is that commonly known as "tilt-up" or flat cast construction which has proved most economical and most readily adopted by the general contractor in southwestern and western United States. This method makes possible savings in material and skilled labor which are becoming more critical under present conditions.

Data and recommended procedures are given for casting platforms, forming methods, bond breaking agents, wall panel design, and construction, and erection of precast members. The patent situation affecting precast construction is discussed briefly.

DIAGONAL TENSION IN REINFORCED CONCRETE BEAMS 48-11

ARTHUR P. CLARK — Oct. 1951, pp. 145-156 (V. 48)

Resistance of reinforced concrete beams to diagonal tension was investigated in a series of tests which included beams with no web reinforcement and beams with varying ratios of web reinforcement consisting of ⅜-in. round deformed bars. Strains in the web and tensile reinforcement were measured with resistance strain gages, deflections of the beams under load were also measured and the number and extent of cracks were observed.

Beams of two cross sections, four span lengths and concrete strengths ranging from 2000 to 6000 psi were tested for five different positions of concentrated loads. One of the results of these tests, not previously demonstrated, is that the position of the loads on a beam influences considerably its shear carrying capacity. An empirical formula based on the data obtained in this study indicates that the shear resistance of the beams varies as the square root of the percentage of web reinforcement and linearly as the compressive strength of the concrete multiplied by a factor representing the ratio of effective depth of beam to distance from plane of the nearest concentrated load point to plane of the support.

CORAL AND SALT WATER AS CONCRETE MATERIALS 48-12

JOHN G. DEMPSEY — Oct. 1951, pp. 157-168 (V. 48)

Concrete in which coral and its related soft and porous limestones are used as aggregate presents more than the usual number of problems in controlling uniformity and quality. Using sea water for mixing has always been a reluctant last resort. Paper describes coral materials, the problems arising from their use, and the methods of mix control used to obtain uniformly satisfactory concrete. Notes on the action of sea water are presented with an account of field experience with it.

LOAD CARRYING CAPACITY OF DOWELS AT TRANSVERSE PAVEMENT JOINTS 48-13

HENRI MARCUS — Oct. 1951, pp. 169-184 (V. 48)

The load carrying capacity of dowels at transverse joints of concrete pavements is dependent on width of joint, size and length of dowel, slab thickness, strength of concrete and steel, dowel alignment and compressibility of the subgrade supporting soil.

To evaluate the efficiency of the dowels, three test groups investigated the effect of various factors: (1) resistance of concrete to bearing stresses distributed uniformly by dowels of different diameters; (2) effect of dimensions and spacing of dowels, dimensions and strength of concrete and compressibility of subbase; and (3) sliding resistance of dowels coated with various substances.

TILT-UP CONSTRUCTION COSTS....48-14

F. THOMAS COLLINS and EARL M. BENNETSEN — Nov. 1951, pp. 197-204 (V. 48)

Cost data for tilt-up construction are broken down into six components — casting platform, forming, casting and curing panels, erection and construction of columns — and compared with a general over-all cost for reinforced brick masonry construction. As with all cost comparisons necessary allowances must be made for local conditions and prices and for changes in the general economic structure. A short form is presented as an aid in estimating costs.

EFFECT OF TEMPERATURE AND SURFACE AREA OF THE CEMENT ON AIR ENTRAINMENT 48-15

E. W. SCRIPTURE, JR., S. W. BENEDICT, and F. J. LITWINOWICZ — Nov. 1951, pp. 205-212 (V. 48)

A number of factors influencing air entrainment have been previously reported. Two further factors affecting the amount of air entrained in concrete mixtures, temperature and the surface area of the cement have been investigated. The amount of air entrained decreases with increasing temperature, expressed as its volume at standard temperature and pressure. With increasing surface area of the cement the amount of air entrained by air-entraining agents decreases but there is no significant variation when no air-entraining agent is used.

FOUNDATION FOR A LARGE TURBOGENERATOR 48-16

PAUL ROGERS — Nov. 1951, pp. 213-224 (V. 48)

A practical method is presented for the structural design of large turbogenerator supports of reinforced concrete. The loads and forces acting on the support are enumerated, their origin is explained and their values are appraised. Computations for one cross bent are presented in detail and the advantages of embedded steel girders to resist horizontal forces, is emphasized.

The method is applicable to the design of foundations for units of 20,000 kw or larger. The general layout and loading arrangement of all makes are similar, only the values of loading and dimensions differ.

MEASUREMENT OF THE DISTRIBUTION OF TENSILE AND BOND STRESSES ALONG REINFORCING BARS 48-17

R. M. MAINS — Nov. 1951, pp. 225-252 (V. 48)

Tensile and bond stresses were measured along reinforcing bars by a new technique which does not disturb bond stresses. Curves for representative beam and pull-out specimens show tensile force distribution, bond stress distribution, applied moment versus measured bar tension, comparison of beam and pull-out tensile force distribution, and applied load versus slip of the bar. Building code requirements imply that bond stress in a beam is a direct function of shear, and that longitudinal distribution of bond stress in a pull-out specimen is uniform. These tests show that these are oversimplifications of the problem, which has been understood (but without experimental proof) for some years. Comparison of ordinarily calculated bond with measured local maximum values shows the calculated values to be frequently less than one-half the values measured in these tests. The effect of standard hooks on the behavior of plain and deformed bars is shown for the particular specimens used. Evidence is presented that cracks in beams decisively affect the magnitude and distribution of tensile and bond stresses — probably one of the more significant results of these tests. Tensile forces in reinforcing bars in beams as ordinarily calculated and as measured in these tests are compared. Calculated values are usually lower than measured values for loads near the ultimate when shear as well as moment acts on the beam.

INSULATION FOR PROTECTION OF NEW CONCRETE IN WINTER 48-18

L. H. TUTHILL, R. E. GLOVER, C. H. SPENCER, and W. B. BIERCE — Nov. 1951, pp. 253-272 (V. 48)

Recent investigations show that new concrete with 1 percent calcium chloride, if kept from dropping below 50 F for 3 days, has sufficient protection from freezing. As an extra precaution, 3 more days protection from dropping below 32 F may be required. Since it is during the first 3 days that considerable heat is generated by the setting cement, it has been learned that insulation, within practical limits, is capable of retaining enough of this heat to keep new concrete from dropping below these temperatures. This avoids construction of special enclosures, fuel costs, and danger of fire. Examples of field applications and tests of insulation are reported together

with resultant concrete temperatures. Also, there are described some aids which have been developed for determining what insulation is necessary under various conditions.

LATERAL FORCE DISTRIBUTION IN A CONCRETE BUILDING STORY....48-19

T. Y. LIN — Dec. 1951, pp. 281-296 (V. 48)

A rational method for the distribution of lateral forces among vertical resisting elements of a concrete building story is presented. The basic theory is given together with examples, including the general case of walls and odd-shaped columns at skew angles to one another.

AIR ENTRAINMENT AND RESISTANCE TO FREEZING AND THAWING 48-20

E. W. SCRIPTURE, JR., S. W. BENEDICT, and F. J. LITWINOWICZ — Dec. 1951, pp. 297-308 (V. 48)

Investigations were undertaken to determine the suitability of various air-entraining agents for use in concrete, the relative effects of slow and rapid cycles of freezing and thawing, and the optimum range of air contents for concrete. With normal air-entraining agents the resistance to freezing and thawing varies mainly with the air content, not with the particular agent used. A rapid freezing and thawing cycle is considerably more destructive than a slow cycle, and abnormal results appear to be produced in some cases by a very fast cycle. With increasing entrained air resistance to freezing and thawing increases to a maximum and thereafter no further benefit appears to be secured. The optimum amount seems to be about 2½ to 3 percent added entrained air.

STREAMLINED VACUUM CONCRETE BUNTONS FOR MINE SHAFTS 48-21

PETER J. DOANIDES — Dec. 1951, pp. 309-320 (V. 48)

Vacuum processed reinforced concrete beams have proved superior to steel and timber for structural bracing elements (buntons) in mine shafts in the gold fields of the Orange Free State, South Africa. Concrete buntons fulfill strength and impact resistance requirements with the additional advantage that they can be streamlined to offer less resistance to flow of air for ventilation and better resist corrosion. Impact, bending and deflection tests are described. These tests of prototype buntons indicated certain weaknesses which were taken into account in redesigning the buntons.

SIMPLE CONCRETE SHELL STRUCTURES 48-22

FELIX CANDELA — Dec. 1951, pp. 321-332 (V. 48)

Some small simply-designed reinforced concrete shells constructed in Mexico City are described. Included are three types of cylindrical shells and two skewed shell structures. They were erected by relatively unskilled labor at a competitively low cost and provided novel solutions to owner's requirements.

CONCRETE FOOTINGS FOR WALLS AND COLUMNS 48-23

PAUL JAKOWLEW-HERBACZEWSKI — Dec. 1951, pp. 333-352 (V. 48)

Equations are developed from which charts and tables are prepared which permit the determination of optimum dimensions for concrete footings. The effect of varying costs of materials is considered and a method is given for determining the economical percentage of steel in concrete.

BUILDING MULTISTORY REINFORCED CONCRETE TANKS 48-24

E. J. CRITZAS — Jan. 1952, pp. 365-372 (V. 48)

A brief description of some of the field problems encountered in building rectangular multistory reinforced concrete tanks used for the storage or fermentation of beer. Tank drainage and plant ventilation required special formwork to provide the necessary warped or sloped surfaces. Specific coverage and placement of reinforcement led to development and use of special precast concrete spacer blocks and metal chairs. Varying job conditions dictated use of both metal and plywood forms and rough surfaces required for bonding corrosion-resistant lining imposed special concrete finishing techniques.

CONSERVATION OF STEEL BY DESIGN 48-25

O. W. IRWIN — Jan. 1952, pp. 373-380 (V. 48)

Conservation of steel is a live issue. Paper is limited to suggestions for saving steel in reinforced concrete design, it does not deal with the broader conservation possible through substituting reinforced concrete for structural steel.

AUTOMATIC JACKS SPEED SLIDING-FORM CONSTRUCTION ...48-26

DAVID F. STOUT and ROBERT E. WILDE — Jan. 1952, pp. 381-392 (V. 48)

Electric jacks which leveled automatically, and threaded steel plugs for joining jack rods, offered advantages in sliding-form construction of a grain elevator. Notable were speedier construction, simpler erection procedure and minimum labor crews. Essential factors in sliding-form construction are reviewed and construction procedures described.

CORRELATION OF SHRINKAGE AND CURING IN CONCRETE MASONRY UNITS 48-27

HARRY W. ESTERLY, JR. — Jan. 1952, pp. 393-404 (V. 48)

Need for a specification defining maximum shrinkage in concrete masonry units has long been recognized. The present specification which limits the amount of moisture in the unit when it is laid is inadequate and cannot be enforced. Paper shows how use of the British specification which limits shrinkage rather than moisture content in the block was applied to block cured by high-pressure steam and by high-temperature steam. High-pressure steam cured blocks shrank only about half as much as those cured by high-temperature steam. The literature on high-pressure steam curing is briefly reviewed and the British standard method of measuring drying shrinkage is shown to be applicable to masonry units manufactured in this country.

EQUIVALENT LOAD METHOD FOR ANALYZING PRESTRESSED CONCRETE STRUCTURES 48-28

ROBERT B. B. MOORMAN — Jan. 1952, pp. 405-416 (V. 48)

A method is presented for post-tensioned reinforced concrete structures whereby the effect of cable tension can be expressed as a distributed or concentrated load. The analysis thus becomes a simple matter of applying methods with which the designer is already familiar. The function of the post-tensioned wires thus can be visualized easily.

WHY SMALL JOBS FREQUENTLY GET POOR CONCRETE 48-29

A. W. BRUST — Jan. 1952, pp. 417-424 (V. 48)

A survey of materials, methods of proportioning, mixing, and placing ready-mixed concrete for housing and small industrial projects. Lack of systematic material and mix control and general absence of field inspection and testing result in great variations in concrete of supposedly uniform quality.

ANALYSIS OF SKEWED RIGID FRAMES AND ARCHES 48-30

JAMES P. MICHALOS — Feb. 1952, pp. 437-456 (V. 48)

A numerical procedure for the analysis of single-span skewed rigid frames and arches, subjected to loads or deformations in any direction, is presented. The structure may have any shape and any variation in cross section along its length. Several examples are included.

USE OF CHICAGO FLY ASH IN REDUCING CEMENT-AGGREGATE REACTION 48-31

C. H. SCHOLER and G. M. SMITH — Feb. 1952, pp. 457-464 (V. 48)

The use of 20 to 30 percent Chicago fly ash, by total weight of fly ash plus cement, effectively and economically inhibits certain types of cement-aggregate reaction in concrete. Fly ash, a finely divided dry powder collected by precipitators from flue gases of pulverized coal-burning power plants, forms a cementing medium when it combines with the lime liberated during the hydration of a portland cement. The data presented refer only to a fly ash obtained from the Chicago area; fly ash from other localities may not necessarily produce the same results since they are known to vary considerably in chemical and physical properties.

Laboratory tests consisted of subjecting 3 x 4 x 16-in. beams to two different accelerated exposures to determine cement-aggregate compatibility. These two accelerated exposures have shown an excellent correlation with observed field service records. Cement-aggregate reaction as referred to in this paper is not restricted to the alkali-aggregate reaction, but refers to the physical and perhaps chemical reactions or a combination of both which causes the expansion that is accompanied by "map cracking."

Use of fly ash produces concretes similar in nature to concretes with ordinary portland cement, with fly ash concretes showing an increase in workability and improved finishing characteristics.

DIRECT DESIGN OF RECTANGULAR COLUMNS WITH BENDING ABOUT AN AXIS OF SYMMETRY 48-32

HENRY J. COWAN — Feb. 1952, pp. 465-484 (V. 48)

A new method for the design of eccentrically loaded reinforced concrete columns based on the principle of superposition. The section is designed to resist the bending moment due to the eccentricity of the column load, using the well-known equations for rectangular reinforced concrete beams; the area of reinforcement is then reduced to allow for the direct compression due to the column load.

In the standard method the dimensions of the section are assumed and the depth of the neutral axis and the maximum stresses in the steel and the concrete are then calculated. In the present method the neutral axis depth ratio is assumed, and the dimensions of the section are calculated from the maximum permissible stresses of the materials; this is therefore a direct design procedure.

Rules are given for determining the depths of the neutral axis so as to produce a section with (a) a specified percentage of tension reinforcement only; (b) a specified percentage of symmetrical reinforcement; (c) the lowest possible area of (unsymmetrical) reinforcement within the limits set by the dimensions of the cross section; and (d) the lowest possible area of reinforcement when the dimensions of the cross section are not limited.

THERMAL EXPANSION OF AGGREGATES AND CONCRETE DURABILITY 48-33

EDWIN J. CALLAN — Feb. 1952, pp 485-504 (V. 48)

Differences in durability of concretes containing aggregates from the same source and similar concretes containing different fine and coarse aggregates are explained partially by differences in thermal expansion of the coarse aggregate and the mortar. Methods were developed to obtain simply the thermal coefficients for numerous aggregates. Concretes were tested in accelerated freezing and thawing, yielding durability factors, *DFE*, for each combination. The *DFE*'s were statistically analyzed with the difference between the thermal coefficients of coarse aggregates and mortars, Δc, and coarse aggregate absorption, A, as variables. For 78 concrete combinations a relation $DFE = 109.65 - 8.76\ \Delta c - 15.22\ A$ was developed with a correlation coefficient of 0.719, which is highly significant. Thus, the durability of these concretes was reduced when the differential expansion of mortar and coarse aggregate increased. Stresses set up by such differential expansion and their effects on concrete durability are discussed briefly. It is concluded that thermal effects of this type should be considered in choosing aggregates for highly durable concretes. The methods developed for determining coefficients of thermal expansion of coarse aggregate and mortar are described.

RELATIVE ECONOMY OF PRESTRESSED AND CONVENTIONAL REINFORCED CONCRETE RESERVOIRS 48-34

G. C. ERNST, C. O. BRUNKEN, and A. R. RIVELAND — Feb. 1952, pp. 505-512 (V. 48)

Cylindrical walls designed for various stress combinations for conventional and prestressed conditions are compared, and the most advantageous are selected for an economy study. Quantities of concrete and steel from 180 complete reservoirs and 80 additional wall designs reveal that those of prestressed concrete have a lower first cost than conventional designs, if the unit cost of the prestressed wall in place does not exceed approximately twice that for the conventional wall. The investigation also showed that in most cases of unrestricted site location with the same controlling water elevation, reservoirs above ground were more economical than underground reservoirs, insofar as first cost is concerned. However, underground reservoirs could compete with those above ground for capacities greater than 2.5 million gal. As to materials, prestressed construction saved from 40 to 60 percent of steel and from 0 to 35 percent of concrete.

NEW TECHNIQUES IN THE STUDY OF SETTING AND HARDENING OF HYDRAULIC MATERIALS 48-35

J. CALLEJA — Mar. 1952, pp. 525-536 (V. 48)

Attempts to establish basic ideas for research on the setting and hardening of hydraulic materials through use of methods based on the variation of the electrical resistance of a paste during its setting period. This method is superior to classical ones, due to its wider application and provision for more detailed data on the phenomenon. Moreover, it can be applied automatically.

Theoretical considerations as well as experimental evidence show that the beginning and end of the setting period are indicated on resistance-time graphs by well defined points closely linked to points of graphs showing temperature changes during setting.

CALCIUM CHLORIDE IN CONCRETE 48-36

J. J. SHIDELER — Mar. 1952, pp. 537-560 (V. 48)

Calcium chloride has been used for many years to accelerate the early strength development of concrete. Its effect on other properties of concrete are not as well known. This paper presents test results on the effects of type of cement, age, temperature, and mix proportions on the strength of concrete containing $CaCl_2$ as well as the effect of $CaCl_2$ on the volume change, heat generation, time of set, alkali-aggregate reaction, resistance to abrasion, and sulfate attack of concrete. References to the work of other investigators and some of their general conclusions are included.

REINFORCING STEEL IN CONCRETE AND THE CONCEPT OF SAFETY. . . . 48-37

K. HAJNAL-KONYI — Mar. 1952, pp. 561-580 (V. 48)

Comparative tests on 36 beams reinforced with various types of large size bars, both in ordinary and high grade concrete, prove the superiority of cold worked steel over steel having a natural yield point as regards safety factor and warning before failure. They also prove the advantage of deformed bars over plain bars regarding bond, crack formation and the necessity of increasing the strength of reinforcement, with improved bond, to avoid failure without warning.

Two beams reinforced with 0.104-in. plain wires with a 268,800 psi tensile strength were also tested. Failure occurred by fracture of the reinforcement although the wires were not prestressed. Cracks were

much narrower than with large size bars at comparable stresses.

Strain measurements, within a wide range of steel stresses and failure (42,500 to 294,200 psi), demonstrate good agreement with Whitney's method of determining the position of the neutral axis.

APPLICATIONS OF VACUUM CONCRETE 48-38

K. P. BILLNER — Mar. 1952, pp. 581-592 (V. 48)

Vacuum concrete processes were introduced in this country a number of years ago and their applications in building construction have been reported in the ACI Journal. During the last few years these processes have become known and adopted in many foreign countries, particularly in Europe, and this paper deals with these foreign developments, singling out new ways and methods in construction.

EXCITING ADVENTURES 48-39

HARRY F. THOMSON — Apr. 1952, pp. 609-612 (V. 48)

Retiring ACI President Thomson reviews the year's activities of the Institute. He considers membership growth, financial condition, staff activities, committee work, special publications, inter-society relations, and Institute meetings. He looks forward to increasing development of new techniques in concrete and new applications of this versatile material.

WAVE VELOCITY IN CONCRETE....48-40

JOHANNES ANDERSEN and POUL NERENST — Apr. 1952, pp. 613-636 (V. 48)

Nondestructive testing of concrete has aroused increasing interest throughout the world as it presents a new approach to determination of concrete quality. A Danish timing device and its application to determination of the wave velocity in concrete specimens is described. The program of hardening of concrete specimens was followed, and a hypothesis for the relation between wave velocity and age is presented. The method has been used on concrete in situ including measurements of concrete members damaged by exposure to fire or freezing at an early age. Measurements on concrete pavements give wave velocities with small variation. An appendix presents detailed procedure for calculating wave velocity and an estimate of concrete homogeneity.

SLIP-FORMS FOR CONCRETE CANAL LINING 48-41

T. V. D. WOODFORD — Apr. 1952, pp. 637-644 (V. 48)

Two types of slip-forms for placing concrete lining in irrigation canals are described. One type, which rides directly on the previously prepared subgrade, is a recent development for use primarily in small canals and farm ditches. Both types of equipment are now in wide use and have effectively reduced the cost of lining operations, fulfilling an urgent need for the conservation of water in the western states.

SHORT CUTS IN THE DESIGN OF CONTINUOUS STRUCTURES 48-42

I. E. MORRIS — Apr. 1952, pp. 645-652 (V. 48)

In preliminary design to determine concrete member sizes or cost comparisons, time-saving methods involving a reasonable degree of accuracy are desirable. Moment coefficients for both positive and negative moments are limited to spans which are approximately equal. In the proposed method, coefficients are used for negative moments only. With known negative moments, positive moments are easily determined by the application of simple statics. Whether the method has the requisite accuracy for a final design depends largely on the implicitness of the designer's faith in elastic stress analysis.

ILLINOIS EXPERIMENTAL CONTINUOUSLY REINFORCED CONCRETE PAVEMENT AFTER FOUR YEARS 48-43

J. D. LINDSAY and H. W. RUSSELL — Apr. 1952, pp. 653-660 (V. 48)

Construction and design features of the experimental continuously reinforced concrete pavement placed in Illinois in 1947 are described. The performance of the pavement up to an age of about 4 years is assessed with stresses in the longitudinal steel, frequency and width of transverse cracks, localized failures and general condition of the pavement being discussed. Economic possibilities of this type of pavement are not considered because of insufficient service life.

EFFECTS OF TEMPERATURE CHANGES ON CONCRETE AS INFLUENCED BY AGGREGATES 48-44

STANTON WALKER, D. L. BLOEM, and W. G. MULLEN — Apr. 1952, pp. 661-680 (V. 48)

Summarizes test of concrete and mortar exposed to water and air temperatures ranging from 40-140 F with varying rates of change in temperature. Changes in length, weight, dynamic modulus, and flexural strength were measured on specimens containing several different fine and coarse aggregates having thermal coefficients of expansion ranging from relatively low to relatively high. Principal findings of the tests were: thermal coefficients of expansion of concrete and mortar containing different aggregates varied approximately in proportion to the thermal coefficient and quantity of aggregate in the mixture; an approximation of the thermal coefficient of expansion of aggregate may be made from determinations of the thermal coefficients of concrete of varying proportions; changes in temperature were destructive to the concrete with sudden changes being much more severe than slower ones; and concretes having higher coefficients of expansion were less resistant to temperature changes than concretes with lower coefficients. No relationship was found between resistance of concrete to temperature changes and differences between thermal coefficients of aggregates and mortar.

BOND PROPERTIES OF WELDED WIRE FABRIC 48-45

ARTHUR R. ANDERSON—Apr. 1952, pp. 681-692 (V. 48)

A wealth of information has been published on bond between concrete and bar reinforcement, but little is known about the bond properties of welded wire fabric reinforcement. Welded wire fabric is widely used as concrete reinforcement, but bond properties have not been clearly established or specified in codes.

The tests reported indicated that the bond stress theory as applied to smooth or deformed bars is not applicable to welded wire fabric. The latter's resistance to slip is not a function of the contact area of the longitudinal wire in the concrete, on the contrary it is dependent on the anchoring ability of the transverse welded wires. The range of the sizes tested show that two welded transverse wires develop sufficient anchorage to develop the ultimate strength of the pull-out wire.

CURING OF CONCRETE 48-46

(Symposium) A. G. TIMMS, D. L. ROBINSON, H. J. GILKEY, ROY W. CARLSON and W. R. JOHNSON, C. E. BURNETT, and H. C. VOLLMER — May 1952, pp. 701-724 (V. 48)

Techniques for concrete must consider all the conditions both natural and artificial that affect the extent and rate of cement hydration. Well-cured concrete does not just happen; it is caused by exercising careful control over the moisture content and temperature of the concrete. A survey of pavement curing methods in the 48 states indicates fairly uniform practice in initial curing methods but wide variations in final curing methods and total time of application. The initial curing method most widely permitted is covering with saturated burlap. For final curing, saturated cotton,

felt or jute mats, membrane compounds, waterproof paper, saturated earth or ponding, and covering with hay or straw are permitted. Length of curing period varies from 72 hr to 7 or more days.

A summary of the factors which relate especially to the curing of concrete in building construction emphasizes where and how these differ from some of the problems encountered in other fields. Current practices, especially with regard to form removal and to temperature and moisture control in cold weather are discussed.

Problems in curing mass concrete are similar to those for smaller sections with the addition of consideration of heat and hydration. Methods used must control the temperature differential between the face and interior of the massive sections. Some remedial measures are creating low temperature in the concrete when placing, limiting the height and rapidity with which the lifts are placed, use of embedded cooling systems or using steel forms which help dissipate the heat. A summary of the recommended curing practices for mass concrete based on the most recent report of Committee 612 is included.

A discussion of membrane curing methods for concrete canal linings points out that white pigmented compound is preferred. Good material, proper time of application, adequate film thickness, and uniform coverage are important.

Standard laboratory and field curing methods are summarized. The influence of economy in the standardization and establishment of acceptable curing specifications is discussed. Use of calcium chloride as a surface treatment or integrally for curing purposes, is explained.

DURABILITY 48-47

C. B. PORTER, R. W. GILMORE, F. H. JACKSON, LEWIS H. TUTHILL, and BYRAM W. STEELE — May 1952, pp. 725-752 (V. 48)

Report on conditions affecting durability of concrete structures, and discussion of design modifications and changes in construction and maintenance procedures to prolong their useful life.

Surveys of structures of various ages and an evaluation of factors affecting their durability. Brief report of research on testing and developing waterproofing materials. A brief discussion of the factors that control durability of concrete pavements. Structural performance and durability are defined and their relationship to each other and to water-cement ratio brought out. The role of air entrainment in improving the durability of concrete pavements, particularly under the attack of chloride salts used for ice removal, is discussed and thinking on the subject summarized.

The necessity of controlling volume change and providing impermeability in mass concrete hydraulic structures contributes to the problems of durability. Mix proportioning, placement methods, use of admixtures, and other measures to increase the serviceability of such work are considered. The need for impermeable concrete is stressed as the primary requirement for lasting durability of mass hydraulic structures. Research in all phases of concrete mix and design is recommended as the answer to the need for a method of evaluating permeability in regard to its permanent effect on the durability of concrete thus establishing a realistic approach to specifying cement content of concrete mixtures in which strength is of secondary importance.

ELECTRIC HEATING OF CONCRETE IN WINTER CONSTRUCTION 48-48

CHUZO ITAKURA — May 1952, pp. 753-768 (V. 48)

Describes an electrical method of heating concrete in cold weather which has been used in about 80 structures in northern Japan. These structures ranged from simple piers for wooden buildings to abutments and piers 82 ft high. The system, employing a network of electrodes, is applicable to plain or reinforced concrete. The cost of curing by this method varies from 7 to 10 percent of construction cost for plain concrete to 10 to 15 percent for reinforced concrete.

FIELD PROBLEMS IN CONSTRUCTING A PRESTRESSED CONCRETE BRIDGE 48-49

CLAIR L. JOHNSON — May 1952, pp. 769-772 (V. 48)

Discusses design considerations for a prestressed concrete bridge in which the girders were assembled from precast blocks grouted after completion of the members. Field experience showed that a reduction in the number of shapes of blocks used was desirable and resulted in lower over-all cost. Breakage of blocks and difficulties in grouting between blocks were overcome by modification and assembling technique, changes in design and the development of re-usable joint covers. Bid prices on three successive jobs indicate that with familiarity with prestressed construction the cost tends to drop.

ECONOMY AND CONCRETE BEAMS 48-50

HERBERT A. SAWYER, JR. — May 1952, pp. 773-784 (V. 48)

Relationships and charts are presented from which may be readily determined the cross-sectional dimensions for maximum economy of materials for a beam or slab with given span and loading. Whitney's theory is used to express beam strength. The steel saving possibilities of economical dimensioning are considered and found especially important.

These optimum dimensions almost never correspond to balanced design, but depend on relative material costs, relative material strengths, relative length of beam reinforced for diagonal tension, and relative importance of beam dead weight.

Optimum dimensions for the Whitney theory also serve as a general guide to efficient design by the elastic theory.

INTRODUCTION TO ULTIMATE LOAD DESIGN 48-51

LEO H. CORNING — June 1952, pp. 797-800 (V. 48)

Review of the history of ultimate load design. Cites precedent for ultimate load design here and in foreign countries with some consideration of the load factors they require.

WHY DESIGN BY THE ULTIMATE STRENGTH THEORIES? 48-52

BOYD G. ANDERSON — June 1952, pp. 801-808 (V. 48)

Discusses following reasons for ultimate design: to bring the design of concrete members into one common rational basis, to make the factor of safety for all shapes the same, to rationalize the use of load factors so that different factors of safety can be assigned to different types of loading and different types of structures, to prevent uneconomical use of compressive reinforcement; to simplify design procedures, to better predict performance of structures subject to long-duration impulsive loads, and to determine capacities of prestressed concrete members.

FUNDAMENTAL CONCEPTS IN ULTIMATE LOAD DESIGN OF REINFORCED CONCRETE MEMBERS. .48-53

EIVIND HOGNESTAD — June 1952, pp. 809-832 (V. 48)

The work of the pioneers of reinforced concrete design was directed primarily towards predicting the strength of members. Ultimate load design is, therefore not a recent development. In principle it is older than the straight-line theory.

The fundamental concepts in ultimate load design of reinforced concrete members are discussed with particular emphasis on the basic assumptions involved, and most common design equations are presented.

It is pointed out that a desirable structure does not necessarily result from truly balanced design, which is characterized by several modes of failure being equally probable. The view is advanced that particularly undesirable modes of failure, such as those having a brittle nature, should be made less probable than modes of failure associated with ductility and warning of distress.

REVIEW OF RESEARCH ON ULTIMATE STRENGTH OF REINFORCED CONCRETE MEMBERS 48-54

C. P. SIESS — June 1952, pp. 833-864 (V. 48)

Extensive and sometimes comprehensive research on the ultimate strength of reinforced concrete members has been carried on almost since the first use of this structural material. Paper reviews briefly some of the more significant work in this field, both experimental and analytical. The scope is limited to statically determinate isolated reinforced concrete structural elements, divided for the purposes of discussion into five categories depending on the predominant type of stress to which they are subjected: (1) pure flexure, (2) axial compression, (3) combined axial compression and flexure, (4) combined flexure and shear, and (5) combined flexure, shear and axial compression. Paper is not intended to be comprehensive; only those tests and theories are discussed that serve best to give an over-all picture of the development and scope of research on ultimate strength of reinforced concrete members.

PRACTICAL DESIGN AT ULTIMATE LOADS 48-55

R. C. REESE — June 1952, pp. 865-880 (V. 48)

After a few comments on the fundamental philosophy of ultimate load design, a short discussion of the formulas used for practical design (rectangular stress prism) is given. Designs are carried out for slabs and beams and for columns with and without bending by the conventional and ultimate load design methods. Some comparisons are made of the results as regards amount of space occupied, time sagging of members, and cost of construction. Remarks are offered on the appropriateness of using elastic frame analysis, plastic theories and the various ultimate stress prisms.

LOAD FACTORS IN ULTIMATE DESIGN OF REINFORCED CONCRETE 48-56

T. Y. LIN — June 1952, pp. 881-900 (V. 48)

Reasons for margins of safety are discussed. Shortcomings of the present method of allowable stresses are enumerated and bases for the choice of load factors in ultimate design are explained. Tentative load factors are proposed.

Proceedings V. 49

SOME EFFECTS OF VIBRATION AND HANDLING ON CONCRETE CONTAINING ENTRAINED AIR 49-1

ELMO C. HIGGINSON — Sept. 1952, pp. 1-12 (V. 49)

The effects of vibration, handling, and delay in placing concrete containing entrained air were evaluated in the laboratory with some check studies made on two large dam construction jobs. Curves of the test results show the rate at which vibration removes air from air-entrained concrete at various slumps. Loss of air caused by handling and delays in placing is determined. The effect of loss of air on the compressive strength and durability of the hardened concrete is evaluated. Evidence is presented that normal vibration does not materially affect bleeding, and that increased vibration may improve the surface appearance of concrete.

CEMENT MORTAR PIPE LININGS.... 49-2

J. WRIGHT TAUSSIG — Sept. 1952, pp. 13-20 (V. 49)

After discussing the reasons for deterioration of metal pipe lines, equipment for cleaning and lining them with cement mortar by the Centriline process is described. The effect of the lining on the carrying capacity of the line is considered and brief data are given on tests to determine the effect of distortion and of holes in the metal pipe on the efficiency of the lining.

FIELD PRACTICE IN LIGHTWEIGHT CONCRETE 49-3

JOHN A. MURLIN and CEDRIC WILLSON — Sept. 1952, pp. 21-36 (V. 49)

Discusses properties of expanded shale and clay aggregates produced in Texas. Considers the use of lightweight structural concrete members and their economy as compared to heavy concrete taking into account the cost differential between the two materials. A practical and simple method for the proportioning and control of lightweight structural concrete, both ready-and job-mixed, which has worked well in the field is discussed. Other sections deal with methods of mixing, placing, finishing, and use of admixtures, and the economy of expanded clay or shale structural concrete.

USE OF CONCRETE IN RESIDENTIAL CONSTRUCTION 49-4

C. O. CHRISTENSON — Sept. 1952, pp. 37-44 (V. 49)

Discusses the need for provisions in the ACI Building Code to meet the specific requirements of home construction. Briefly describes research in housing problems in the United States. Gives typical designs for concrete foundation slabs for homes in mild and cold climates. Illustrates the use of tilt-up construction in a multiple housing project.

PRACTICAL DESIGN OF THIN RETAINING-WALL FOOTINGS 49-5

R. P. V. MARQUARDSEN—Sept. 1952, pp. 45-56 (V. 49)

Approximate formulas are presented for locating the points beyond which soil pressure does not affect bending and shearing stresses in the footing. A means of ascertaining the net vertical soil pressures and the resulting shear and bending moments is included. Once these values are established, the design of the footing may proceed in the usual manner.

ANALYSIS OF BEAM-AND-GIRDER FRAMING WITH KNOWN COLUMN SETTLEMENTS 49-6

PHIL M. FERGUSON — Oct. 1952, pp. 77-84 (V. 49)

Systematic tabulation of data and the development of relatively simple criteria for checking the equilibrium of joints between columns make analysis by successive approximations entirely practical. Moment distribution tabulations are laid out on a plan view of the framing. Separate, but similar tabulations, are used for moments about the x-x and y-y axes. Beam-and-girder intersections are treated as joints whose elevations are first estimated. Fixed-end moments due to joint deflections are balanced; then summations of vertical forces (shears) at the joints indicate the corrections needed to move nearer equilibrium.

PROPOSED DEFINITIONS AND NOTATIONS FOR PRESTRESSED CONCRETE 49-7

ACI ASCE COMMITTEE 323 — Oct. 1952, pp. 85-88 (V. 49)

Proposes definitions and notations for general adoption in discussing prestressed concrete and for design purposes.

EFFECT OF COMPRESSIVE REINFORCEMENT ON THE PLASTIC FLOW OF REINFORCED CONCRETE BEAMS 49-8

G. W. WASHA and P. G. FLUCK — Oct. 1952, pp. 89-108 (V. 49)

Presents test results obtained during 2½ years of sustained loading of 34 reinforced concrete beams. Thirty of the beams were made with sand-gravel concrete containing Type I portland cement. Three conditions of reinforcement were investigated in each of five different beam sizes. One-third of the beams had only tensile steel, one third had tensile steel plus an equal amount of compressive steel, and one-third had tensile steel plus one-half as much compressive

steel. Strain measurements at the levels of the compressive and tensile reinforcement and deflection measurements provide a clear picture of the beneficial effect of compressive reinforcement in reducing excessive plastic flow.

Four additional beams were made with only tensile steel. Two of the beams were made with sand-gravel concrete containing Type IA cement and two with a lightweight expanded slag aggregate concrete containing Type I cement. These four beams were included in the test program to provide preliminary information regarding the influence of entrained air and one type of lightweight aggregate on the plastic flow of reinforced concrete beams.

HEAVY DUTY CONCRETE FLOORS 49-9

E. E. ECKERT — Oct. 1952, pp. 109-116 (V. 49)

Brief but specific directions for mixing, placing, finishing, and curing concrete for heavy duty concrete floors. Emphasis is on the careful control of mixing water and the selection, handling, and use of a tough durable aggregate. Precautions are given for avoiding subsequent failure.

INELASTIC BEHAVIOR IN TESTS OF ECCENTRICALLY LOADED SHORT REINFORCED CONCRETE COLUMNS 49-10

EIVIND HOGNESTAD — Oct. 1952, pp. 117-140 (V. 49)

Presents methods and results of an experimental and analytical investigation undertaken to throw new light on the behavior of reinforced concrete members subject to combined bending and axial load. Describes observations of basic behavior of such members and indicates mathematical expressions for ultimate loads.

A total of 120 column specimens were tested, of which 90 were 10-in. square tied columns with 11.46 to 4.8 percent reinforcement, and 30 were 12-in. cylindrical spiral columns with 4.25 percent longitudinal reinforcement. The concrete quality was varied from 1500 to 5500 psi, and the eccentricity of loading varied from 0 to 1.25 times the laterial dimension of the columns.

An inelastic flexural theory was developed, by means of which the behavior of the test columns may be explained, and the measured ultimate loads may be predicted with a satisfactory accuracy.

INSTRUMENTATION AND STRAIN MEASUREMENT IN WELDED WIRE FABRIC REINFORCED CONCRETE SLABS 49-11

E. W. CARLTON and J. S. SENNE — Oct. 1952, pp. 141-152 (V. 49)

A study of the stress distribution and proper spacing of longitudinal and transverse wires in welded wire fabric. Discussed is the development of a weld-tester, to be used as a production control in the manufacture of wire fabric and as an acceptance standard for users of the product. A technique for attaching SR-4 strain gages to wire reinforcement is introduced. Charts are included to show results of tests together with discussion and conclusions.

PROPOSED REVISION OF MINIMUM STANDARD REQUIREMENTS FOR PRECAST CONCRETE FLOOR UNITS (ACI 711-46) 49-12

COMMITTEE 711 — Nov. 1952, pp. 169-184 (V. 49)

Superseded by 50-1

Proposes to change the existing Standard by adding descriptions of assembled concrete block, precast inverted T-beam joist with precast filler blocks, and inverted precast slab and T-joist types of floor units. New information is incorporated on moment bar spacing, steel requirements, distance between lateral supports, and provisions for tests. References to the ACI Building Code are brought up to date and the Appendix excerpts are taken from the 1951 Building Code. Minor editorial changes are made to clarify some of the other sections.

T-BEAM DESIGN AND THE 1951 ACI BUILDING CODE 49-13

BENJAMIN A. WASIL — Nov. 1952, pp. 185-192 (V. 49)

Describes the design of a T-beam by use of ACI 318-51 and demonstrates that it is not simply the substitution of the new bond and shear values for those of the 1947 Code. A balance must be achieved between concrete and steel and this is done by proportioning the beam so that steel required for positive moment can be used, when extended into the support, for compression reinforcement.

EFFECT OF TIME OF APPLICATION OF SEALING COMPOUND ON THE QUALITY OF CONCRETE 49-14

G. E. BURNETT and M. R. SPINDLER — Nov. 1952, pp. 193-200 (V. 49)

Laboratory experiments with mortar specimens indicate an advantage for applying curing compound to unformed concrete at approximately the time of set. Loss of mixing water from evaporation up to this point is shown to be beneficial to strength and abrasion resistance. Subsequent loss is shown to be detrimental. The benefit from loss of water before set appears to be directly related to the decrease in water-cement ratio.

DEVELOPMENT OF A DEVICE FOR THE DIRECT MEASUREMENT OF COMPRESSIVE STRESS 49-15

ROY W. CARLSON and DAVID PIRTZ — Nov. 1952, pp. 201-216 (V. 49)

Describes the development, analysis, and testing of a device called a "stress meter" which measures compressive stress in concrete more or less directly. It shows that it is possible to make an embedded device which at all times registers nearly the same stress as the surrounding concrete, regardless of the deformations, and it reports tests wherein stress meters embedded in a concrete specimen were shown to be practically insensitive to creep under sustained load and to maintain the same zero-stress reading when the specimen was subjected to a variety of conditions. The stress meters also indicate nearly the correct stress when loaded at various ages, although the modulus of elasticity of the concrete changes markedly.

SULFATE RESISTANT CEMENT — PRIMARY REQUIREMENT FOR SULFATE RESISTANT CONCRETE PIPE 49-16

DALTON G. MILLER — Nov. 1952, pp. 217-224 (V. 49)

Results are sited of long-time tests of 19 regular portland cements and 19 companion cements from the same mills which had been modified by raising the iron-alumina ratio from an average of 0.45 to 0.96, thus reducing the calculated compound tricalcium aluminate (C_3A) from an average of 10.0 to 4.7 percent. The marked influence of changes in the percentage of C_3A on the sulfate resistance of a portland cement is discussed.

FREE-SPAN PRESTRESSED CONCRETE BRIDGE 49-17

U. FINSTERWALDER — Nov. 1952, pp. 225-232 (V. 49)

Short description of prestressing system and construction of the bridge over the Neckar river in Neckarrems, Germany, using a free-span prestressed concrete system.

BRACING WALLS FOR MULTISTORY BUILDINGS 49-18

NORMAN B. GREEN — Nov. 1952, pp. 233-248 (V. 49)

Methods are developed for the stress analysis and design of the multistory reinforced concrete bracing wall, by treating it as a special type of beam and column frame having relatively wide members. Elastic requirements for a bracing wall are established. There is a discussion of the general problem of lateral load distribution to bracing walls and an entirely new method of distribution is presented, which equalizes wall deflections.

SPACING OF SPLICED BARS IN TENSION PULL-OUT SPECIMENS . . . 49-19

S. J. CHAMBERLIN — Dec. 1952, pp. 261-276 (V. 49)

The effect of spacing of parallel bars was investigated with tension pull-out specimens. Prisms of concrete, square in cross section and of variable length, contained three bars; one bar was embedded along the vertical axis and extended downward, two other bars paralleled the center bar and extended upward. Slip of the center bar was measured at both the loaded and free end. Symmetrical spacing between the bars, from adjacent-tied to a clear separation of three bar diameters, was the major variable. Three different concretes and three types of bar — plain, one type of old-style deformed, and one type of new high-bond — were included.

Results indicate that the bond of plain bars is not appreciably affected by spacing of the bars. Bars having one type of old-style deformations and bars having one type of deformation meeting current requirements for deformed bars developed better average bond stresses in adjacent-tied splices even without mechanical interlock than in spaced splices. Spacings, other than adjacent-tied, do not appear to affect bond significantly.

STABILITY OF THIN-SHELLED STRUCTURES 49-20

GEORGE C. ERNST — Dec. 1952, pp. 277-292 (V. 49)

A brief history of the development of various theories for determining the failing load for structural members subjected to compression provides the background for the presentation of test results confirming the validity of certain concepts. The two most widely accepted and used methods are presented, namely the empirical and tangent-modulus methods, with specific adaptation to thin-shelled reinforced concrete construction. Past tests are reviewed briefly and a series of new tests are presented to illustrate thin-shelled instability characteristics, as well as to confirm the use of either of the two methods.

EARLY FREEZING OF NON-AIR-ENTRAINING CONCRETE 49-21

DONALD C. McNEESE — Dec. 1952, pp. 293-300 (V. 49)

The critical period when freshly placed concrete is damaged by freezing has not been definitely established. To obtain data on this subject, test cylinders were frozen at various intervals up to 6 hr after molding and at temperatures from 25 to −15 F. Cylinders molded at 75 F and subjected immediately to a freezing temperature of 15 F lost about 40 percent of their compressive strength. When given more time to set before freezing, the damage was less. There was practically no loss of strength when the cylinders set 6 hr before freezing at 15 F. Cylinders exposed to 5 F lost 50 percent of their strength when frozen immediately, and 15 percent when frozen after 6 hr.

A more critical condition existed when concrete was mixed from cold materials. Cylinders molded at 40 F lost 50 percent of their compressive strength when frozen at the mild temperature of 25 F. Concrete molded at 40 F and frozen immediately at −15 F lost 45 percent of its strength. A 50 percent loss of strength was about the maximum for any freezing condition. The length of time the concrete remained frozen or the temperature to which it was lowered once it was frozen through did not greatly affect the compressive strength.

DETERMINING CABLE PROFILES FOR PRESTRESSED CONCRETE BEAMS 49-22

ELIHU GEER — Dec. 1952, pp. 301-304 (V. 49)

A method is presented for constructing a diagram for determining satisfactory cable profiles for prestressed concrete beams in which compressive stress is critical at only the section of maximum moment. A second method is presented for satisfying all conditions imposed by permissible stress, tensile and compressive, in a beam of varying depth and in a continuous beam.

METHOD FOR PREPARING SR-4 STRAIN GAGES FOR EMBEDMENT IN CONCRETE 49-23

EDWARD C. THOMA and ROBERT E. SCHNEEBELI — Dec. 1952, pp. 305-316 (V. 49)

It has long been appreciated that analysis of concrete structures might be improved if a suitable means could be established for determining the behavior in the interior of a concrete mass. The very nature of its manufacture produces a heterogeneous material, thereby invalidating the assumption of homogeniety which can be applied with reasonable truth in developing theoretical analysis of most engineering materials. Aggregate distribution within the mass, gradation, maximum particle size and other variables influence the behavior of a concrete structure.

This paper presents a procedure for preparing and installing the SR-4 wire resistance strain gage within a concrete mass for the purpose of determining the behavior in the interior. Controlled laboratory studies of the gage unit itself, as well as gage units embedded in mortar and concrete, are reported to establish the reliability of the prepared SR-4 gage. In addition, preliminary studies of a field application, namely a highway slab installation, are included since they further establish the practicality and long-range reliability of the gage under severe test conditions.

LIMIT ANALYSIS OF VOUSSOIR (SEGMENTAL) AND CONCRETE ARCHES 49-24

ANTHONY KOOHARIAN — Dec. 1952, pp. 317-328 (V. 49)

The voussoir arch is composed of many individual sections fitted one on another to form an arch. The strength of these arches depends primarily on distribution of dead load and depth of the voussoirs.

Analysis and design problems associated with the voussoir arch are essentially the same as those of the unreinforced concrete arch. This structure may be analyzed by either the usual standard analysis or by limit analysis. This paper describes and studies both methods of analysis, with emphasis on the advantages of limit analysis to this type structure.

EFFECT OF CURRENT FREQUENCY ON MEASUREMENT OF ELECTRICAL RESISTANCE OF CEMENT PASTES . . . 49-25

J. CALLEJA — Dec. 1952, pp. 329-332 (V. 49)

Presents results obtained in a short study to determine the influence of frequency of the current employed for measuring electrical resistance of a cement paste, to establish the beginning and end of the setting period.

It was found that frequency of the current has no influence on the values found, although it is advisable to employ a frequency not smaller than 1000 cycles.

PROPOSED STANDARD SPECIFICATION FOR THE DESIGN AND CONSTRUCTION OF REINFORCED CONCRETE CHIMNEYS 49-26

COMMITTEE 505 — Jan. 1953, pp. 353-400 (V. 49)

Superseded by 51-1

This revised specification sets forth recommended loading, including provision for both wind and earthquake, for the design of reinforced concrete chimneys and recommended methods for determining the stresses in the concrete and reinforcement resulting from these loadings. The method of analysis includes determination of the stresses at horizontal cross sections where flue or other openings occur as well as at sections where the cross section is an annular ring. Charts containing curves to aid in the rapid solution of the specified formulas are included. While the method of analysis applies primarily to chimneys, it can be used for other hollow circular cross sections, with or without openings, where the shell thickness is small in proportion to the diameter.

Formulas are recommended for determining the temperature gradient through the concrete resulting from

the difference in temperature of the gases inside the chimney and the surrounding atmosphere, together with methods for determining the stresses in the concrete and reinforcement both vertically and circumferentially due to the temperature gradient through the concrete.

Formulas for combining the stresses due to dead, wind, and earthquake loads with the stresses due to temperature are included in the specification, together with recommended allowable stresses in the concrete and reinforcement for the various stress combinations.

The specification covers the mixing and placing of the concrete by reference to the ACI "Building Code Requirements for Reinforced Concrete" (ACI 318 — latest revision) with supplemental provisions to take care of the special requirements for concrete chimneys.

The specification also includes recommended practice for linings for concrete chimneys, where required, for lightning protection, access ladders, and other chimney accessories.

In an appendix many of the equations used are derived and the assumptions on which they are based are given.

PROGRESS REPORT IN PRESTRESSED CONCRETE 49-27

MYLE J. HOLLEY, JR. — Jan. 1953, pp. 401-408 (V. 49)

Brief review of developments in linear prestressed concrete in the United States since the First U. S. Conference on Prestressed Concrete. Though European construction and achievements in prestressing continue to lead those in this country, there are now about 100 known projects in the United States incorporating linear prestressed concrete construction, either completed or under construction — about a ten-fold increase in 1 year. While foreign-developed prestressing systems have been widely used, there has also been widespread application of methods developed in this country.

PRESTRESSED CONCRETE IN TAMPA BAY BRIDGE 49-28

W. E. DEAN — Jan. 1953, pp. 409-420 (V. 49)

The Lower Tampa Bay bridge in Florida is noteworthy in several respects. The 15-mile crossing will include approximately 3½ miles of concrete trestle constructed with precast and prestressed concrete beams. The bridge includes 363 prestressed concrete stringer spans, each 48 ft long. The reinforcement consists of high-strength Lee-McCall bars, the first structure in this country to employ this prestressing system.

A test program on full size members was set up prior to beginning construction of the bridge. This also gave the contractor a chance to perfect construction procedures, which are outlined in the paper. Test results on a beam aided in establishing an empirical standard of quality to apply to the manufacture of units to be used on the job. A "composite beam" was tested to investigate the action of the composite T-section consisting of beam and deck slab.

DESIGN AND CONSTRUCTION OF A FULLY VIBRATION-CONTROLLED FORGING HAMMER FOUNDATION. .49-29

ALDEN M. KLEIN and J. H. A. CROCKETT—Jan. 1953, pp. 421-444 (V. 49)

The necessity of overcoming enormous ground vibrations due to forging operations and a desired lowering of production costs through lesser maintenance led to an entirely new design of a foundation for an 8-ton forging hammer.

This hammer is the first to be fully analyzed for shock, vibrations, movements, and loads in all directions, the first to be built with prestressed concrete, the first to use high strength grouted concrete. The high strength and homogeneity requirements for the concrete and the extremely difficult placing conditions were met and overcome through the use of specially designed high strength grouted concrete.

WHAT DO WE NEED TO KNOW ABOUT PRESTRESSED CONCRETE? 49-30

N. M. NEWMARK — Jan. 1953, pp. 445-456 (V. 49)

A discussion of the more important points of uncertainty in our knowledge of prestressed concrete concerning which laboratory and field research is needed. There are many quantitative problems of detail which are not discussed; however, the major problems of principle are described.

The most important aspect of the problem is concerned with the basic philosophy of design. This involves selecting factors of safety or load factors, and must be solved before a consistent design procedure can be formulated.

PRESTRESSED CONCRETE GIRDERS SPAN COLLEGE HALL 49-31

CURZON DOBELL — Jan. 1953, pp. 457-468 (V. 49)

The 65-ft prestressed concrete girders at Manhattanville College do not represent any spectacular advance in the use of prestressed concrete. They do, however, constitute the first major application of prestressing to building construction in this country and demonstrate a new system of tensioning and anchoring parallel wire cables with greater control and accuracy than was possible heretofore.

PRESTRESSED CONCRETE WINS PLACE IN MASSACHUSETTS BRIDGE PROGRAM 49-32

J. C. RUNDLETT — Jan. 1953, pp. 469-484 (V. 49)

In constructing a 28-ft span prestressed concrete bridge, the Massachusetts Department of Public Works was able to evaluate the use of prestressing as well as gain experience for future construction. Design and construction problems are considered. Tests on full scale prestressed beams bore out the design criteria except that the loss in prestressing indicated that an allowance of 15 percent is insufficient.

LOOKING TO THE FUTURE IN PRESTRESSED CONCRETE CONSTRUCTION 49-33

J. F. JELLEY — Jan. 1953, pp. 485-488 (V. 49)

Summarization of progress in prestressed concrete construction. Emphasis is placed on projects described in preceding papers and their part in pointing the way to future construction and greater use in America of this building technique.

CONSTRUCTION PROBLEMS OF PRESTRESSING 49-34

MAXWELL UPSON — Jan. 1953, pp. 489-496 (V. 49)

Prestressing has offered a solution to the problem of getting the steel and concrete in reinforced concrete to act together more as a homogeneous whole than has heretofore been possible. Results of experiments with various types of prestressed piling have proved the applicability of this construction technique and illustrate the savings in materials that accrue from the use of prestressing. Use of prestressing in concrete sheet piling and hollow concrete piles is described.

CONSTRUCTION ASPECTS OF THIN-SHELL STRUCTURES 49-35

ANTON TEDESKO — Feb. 1953, pp. 505-520 (V. 49)

Since material costs for thin-shell type structures represent a relatively lower percentage of total cost, form design, handling of formwork, and labor take on added importance. Construction techniques — form centering, concreting, decentering, and movement of forms — are discussed. Cost and labor requirements for a typical project are given.

REINFORCED CONCRETE THIN-SHELL STRUCTURES 49-36

CHARLES S. WHITNEY — Feb. 1953, pp. 521-536 (V. 49)

This paper supplements the report of the American Society of Civil Engineers' subcommittee on thin shells by illustrating more fully the possibilities of thin shell construction. Examples of completed and proposed

structures are given and dimensional data are presented in tabular form. Roof structures consisting of thin membranes of reinforced concrete, curved in one or more directions, are of quite recent origin, but their development has been rapid and they offer important possibilities for economical construction where loads are principally distributed loads due to dead weight, wind, and snow loading.

PRECAST CONCRETE OFFERS NEW POSSIBILITIES FOR DESIGN OF SHELL STRUCTURES 49-37

PIER LUIGI NERVI — Feb. 1953, pp. 537-548 (V. 49)

Bold use of precast concrete in construction of various types of shell structures offers savings in material and formwork costs, as well as facilitating rapid construction. Outstanding examples of thin-shell construction, such as hangars, exhibition halls, and even naval vessels, are described. Special emphasis is placed on the use of precast elements in arched roofs, proving that precast and cast-in-place concrete can be used together, without losing the advantages of either. Details are given on the utilization of thin precast units in corrugated barrel vault structures.

DESIGN OF PRISMATIC SHELLS 49-38

HERMANN CRAEMER — Feb. 1953, pp. 549-564 (V. 49)

Differential equations for prismatic shells, based on the deflections of the edges, are derived and integrated for several single-span systems of various cross-sectional types. Depending on the cross section and the span, there is a gradual transition from a pure shell effect to that of a thin-walled beam.

PRECAST CONCRETE IN HIGHWAY BRIDGE CONSTRUCTION 49-39

E. L. ERICKSON — Feb. 1953, pp. 565-572 (V. 49)

Precasting of reinforced concrete highway bridges has developed in some areas of the United States to a point where it has been demonstrated quite conclusively that the method has definite advantages in many instances over conventional cast-in-place construction and structural steel. Systems which have been used in the past and those which are in use today are described. References to specific jobs show the possibilities of precast bridge construction especially as applied to short span highway structures. Attention is called to the need for standardization so that bridge members of precast concrete can be manufactured in factories on a commercial basis if maximum economy is to be obtained.

ULTIMATE STRENGTH AND CRACKING RESISTANCE OF LIGHTLY REINFORCED BEAMS 49-40

S. D. LASH — Feb. 1953, pp. 573-584 (V. 49)

The ultimate strength of beams reinforced with 1 percent or less of intermediate grade steel is somewhat greater than that indicated by either the plastic or conventional theories. This is because the theories neglect the effect of concrete in tension below the neutral axis. The excess is not great except for beams made with high strength concrete and small amounts of steel.

Cracking resistance of lightly reinforced beams depends on the strength of the concrete and the amount of reinforcement. The tensile modulus of rupture of the concrete is increased significantly by the presence of reinforcement.

Deflection of a beam at yield of steel is independent of the amount of steel, provided the ratio of reinforcement is 0.7 percent or more. Below this limit the deflection diminishes and may be quite small.

BEHAVIOR OF COMPOSITE T- BEAMS WITH PRESTRESSED AND UNPRESTRESSED REINFORCEMENT ..49-41

STEPHEN REVESZ — Feb. 1953, pp. 585-592 (V. 49)

Five different composite T-beams were tested to destruction to observe the behavior under loading. Reinforcement in four of the beams consisted of 0.105-in. diameter high tensile strength wire, tensioned to various stresses. For comparison, one beam was reinforced with mild steel. Deflections, strains, and crack widths were measured and recorded.

Design and ultimate loads are examined in the light of estimated values based on simplified assumptions. Observations are drawn regarding warning of failure.

TEN-YEAR REPORT ON THE LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE 49-42

ADVISORY COMMITTEE, LONG-TIME STUDY — Mar. 1953, pp. 601-616 (V. 49)

Primarily, this study was undertaken to determine whether any relationship exists between the composition, fineness, and conditions of manufacture of the test cements and the ability of the concrete in which they were used to resist disintegration when subjected to external influences such as water, sulfate solutions, temperature changes, and highway traffic with or without application of salts for ice removal; and internal changes due to instability of the hardened cement paste.

Most of the test structures have now been exposed to weathering for 10 years and this report presents the most important facts regarding the cements and their performance. Conclusions are presented concerning the lack of correlation between the behavior of concrete exposed to freezing and thawing and the chemical content or fineness of the cement; normal differences in manufacture do not significantly affect durability of concrete; and the increase of sulfate resistance with reduction of potential C_3A content of the cement. Substantiating other studies, the evidence was strong that air entrainment greatly increases the ability of concrete to endure freezing and thawing without deterioration and was found to be particularly effective in preventing scaling when chlorides are used for ice control on concrete pavements.

(See also 44-21, 44-26, 44-33, 44-38, 46-17, 47-51, 52-13, 54-27, and 54-59)

CONTINUOUS PRESTRESSED CONCRETE BEAMS 49-43

FRITZ LEONHARDT — Mar. 1953, pp. 617-636 (V. 49)

One of the major problems in design and construction of continuous prestressed concrete beams is the friction between the prestressing steel and the cable casing. Measures for reducing this friction are discussed and include the use of sliding provisions in the cable channels, concentrating the prestressing steel in a few cables, and arranging the cables in horizontal layers instead of a circular or ringlike arrangement. Instead of curving the prestressing elements continuously, a polygonal shape can be used, made up of long straight lines and short curved sections. Reducing friction without disturbing bond of the cables to the concrete can be accomplished by keeping the proper relationship between straight and curved portions. By the use of these measures, friction coefficients as low as 0.07 have been attained on a three-span girder.

YIELD-LINE THEORY FOR THE ULTIMATE FLEXURAL STRENGTH OF REINFORCED CONCRETE SLABS 49-44

EIVIND HOGNESTAD — Mar. 1953, pp. 637-656 (V. 49)

An outline is presented of the yield-line theory, a plastic theory for the prediction of ultimate flexural strength of reinforced concrete slabs, developed by K. W. Johansen. The theory is based on plastic behavior occurring in a pattern of yield lines, the location of which depends on loading and boundary conditions. The ultimate flexural strength may be evaluated, even for complex slabs, with limited mathematical effort. The theoretical strengths obtained are in good agreement with experimental results, and generally on the safe side thereof. The use of the theory is illustrated by numerical examples.

SKEW SHELL UTILIZED IN UNUSUAL ROOF 49-45

FELIX CANDELA — Mar. 1953, pp. 657-664 (V. 49)

Describes a shell arranged as a smooth conoidal double canopy, cantilevered 16 ft on both sides and supported on stone walls at the ends of its curved directrix. The general dimensions are 20 x 40 ft, with a thickness varying from 1¼ to 4¾ in.

Although the rigorous stress analysis of such a surface would be complicated, its relatively small size and curvature permits an approximate investigation which amounts to substitution of two straight lines converging at the arch apex for the curved directrix.

DIAGONAL TENSION IN T-BEAMS WITHOUT STIRRUPS 49-46

PHIL M. FERGUSON and J. NEILS THOMPSON — Mar. 1953, pp. 665-676 (V. 49)

Tests on 24 T-beams without stirrups are reported. The chief variables are the effect of changing the concrete strength and the effect of extra web width over part of the beam depth. It is concluded that diagonal tension strength goes up very slowly as f_c' increases; that a unit shear working stress of $0.03f_c'$ is too high for beams of this type made of high strength concrete, and that extra web area is helpful even where it does not increase the minimum b' width.

The shear span-depth ratio is emphasized as a factor in planning or evaluating an investigation into diagonal tension strength.

FIRE RESISTANCE OF REINFORCED CONCRETE FLOORS 49-47

J. P. THOMPSON — Mar. 1953, pp. 677-680 (V. 49)

A general discussion of the fire resistance of reinforced concrete floors — what has been done in the past, what is known at present, and what may be expected in the future. A recent test program by PCA is discussed. To obtain information on heat transmission through concrete floors and on the structural stability with usual amounts of protection for the reinforcement, the first tests were of solid one-way slabs of different thicknesses and different concretes.

THE SERVICES OF THE AMERICAN CONCRETE INSTITUTE 49-48

A. T. GOLDBECK — Apr. 1953, pp. 697-700 (V. 49)

Retiring ACI President Goldbeck discusses the early days of the Institute and the wide range of subjects covered by papers published in the Proceedings over the years. Standards and special publications are enumerated and the great amount of volunteer effort making them possible is noted. Conventions and regional meetings are seen as opportunities for personal contacts as well as sources of more formal information. Recent staff changes, membership trends, and prospects for the future are mentioned.

STRENGTH AND DURABILITY OF CONCRETE CONTAINING CHICAGO FLY ASH 49-49

G. W. WASHA and N. H. WITHEY — Apr. 1953, pp. 701-712 (V. 49)

Results of laboratory tests indicate the strength that can be obtained when various amounts of Chicago fly ash are used in concrete mixes under various conditions. Results of a group of freezing and thawing tests show that air-entrained concretes made with and without Chicago fly ash are equally frost resistant. Chicago fly ash in concrete made with Type I portland cement increased resistance to attack by sulfuric acid. The tests were confined to fly ash from one electric utility company in Chicago and are not necessarily applicable to fly ashes from other sources.

PRODUCTION OF COMMERCIAL BLAST FURNACE SLAG 49-50

FRED HUBBARD — Apr. 1953, pp. 713-720 (V. 49)

Discusses the types of blast furnace slag produced commercially; geographic availability; extent to which slag produced at blast furnaces is commercialized; usual chemical composition; and production procedures which differ from those of other aggregates.

RECENT CHANGES IN CORPS OF ENGINEERS CONCRETE CONSTRUCTION SPECIFICATIONS 49-51

GEORGE L. OTTERSON and WOODROW L. BURGESS — Apr. 1953, pp. 721-728 (V. 49)

Describes Corps of Engineers documents which contain concrete construction policies of that organization. A recent change is the preparation of two guide specifications permitting the selection of provisions best adapted to the project and aimed at greater uniformity in small jobs.

Control measures for aggregate gradation, particle size, and uniformity are varied with the use of these materials in lean mass concrete or high-cement-factor concrete. Type II cement is generally specified although other types may be used where job conditions require them or costs permit their use.

Limits for air entrainment are raised to a range of 4 to 7 percent induced by the addition of air-entraining admixtures at the mixer. Water curing of concrete is the general practice with pigmented membrane curing compounds permitted where job conditions make water curing impractical.

Several classes of formed surfaces, depending on structural requirements, are specified and three types of control measures are provided for depending on the type of structure.

Conditions are also set down for mixing plant, reinforcing steel, water stops, and prepacked concrete.

EFFECT OF STRAINING RATE ON THE COMPRESSIVE STRENGTH AND ELASTIC PROPERTIES OF CONCRETE 49-52

D. WATSTEIN — Apr. 1953, pp. 729-744 (V. 49)

The effect of the rate of application of load was investigated using bonded wire strain gages in compressive tests of two concretes having approximate compressive strengths of 2500 and 6500 psi. The concrete was tested in the form of 3x6-in. cylinders at rates of straining ranging from 10^{-6} to about 10 in. per in. per sec, with the corresponding durations of test ranging from 30 min to 0.0003 sec. The higher rates of straining were obtained by loading the concrete specimens in a drop-hammer machine. The rate of loading in the drop-hammer machine was controlled by placing rubber buffers of appropriate thickness and hardness on top of the concrete specimens.

The compressive strength of the concrete increased with the rate of loading. The maximum ratio of dynamic to static compressive strengths was about 1.8 for a rate of straining of 10 in. per in. per sec. The values of the secant moduli of elasticity increased significantly with the rate of application of load; the maximum ratio of dynamic to static modulus was 1.47 for the "weak" concrete and 1.33 for the "strong" concrete. Resistance of the concrete to impact as measured by its ability to absorb strain energy also increased with the rate of application of load.

PHYSICAL PROPERTIES OF HIGH-PRESSURE STEAM-CURED CONCRETE BLOCK 49-53

COMMITTEE 716 — Apr. 1953, pp. 745-756 (V. 49)

Three methods for determining drying shrinkage of high-pressure steam-cured concrete block are described and results compared. A rapid method requiring only 24 hr immersion was found to be as practical as methods requiring 96 hr immersion for determining absorption and moisture losses. For measuring shrinkage, the rapid method is satisfactory provided allowance is made for the fact that the values determined are approximately twice those found in service.

A device for measuring tensile strength of concrete in whole block is described and illustrated. Although still under development test results were in good agreement.

THIN-SHELL PRECAST CONCRETE — AN ECONOMICAL FRAMING SYSTEM 49-54

A. AMIRIKIAN — May 1953, pp. 773-780 (V. 49)

The framing arrangement generally referred to as "thin-shell precast concrete" has been the subject of many inquiries from engineers and builders. Some of the questions indicate that the system is not as yet fully understood or properly distinguished from conventional precast concrete. Others, who contemplate the utilization of this new method of construction, express some concern regarding certain phases of the novel technique. Still others want to know more about the actual applications and the experiences and opinions of the users. The introductory notes of this paper, together with five papers arranged in the form of a symposium, are presented to furnish timely information on this type of construction.

THIN-SHELL RIB PANELS SITE FABRICATED IN PLASTIC MOLDS. . . . 49-55

M. R. MONTGOMERY and T. G. ATKINSON — May 1953, pp. 781-796 (V. 49)

Equipment, methods, and materials used in the field casting of thin-shell precast panels are described. The contractor's basic problem is outlined; experimental operations resulting in final method are touched briefly, together with fairly complete description of the methods used. While primarily concerned with casting of units, certain erection problems are so related with the casting that they are briefly brought in. The effect on casting economy is also closely related to architectural and engineering design. Therefore, recommendations and conclusions are included which it is believed will increase the efficiency and economy of precast panel construction.

FACTORY PRODUCTION AND FIELD INSTALLATION OF THIN RIBBED PRECAST PANELS 49-56

C. D. WAILES, JR. — May 1953, pp. 797-808 (V. 49)

Three hundred and fifty thousand square feet of precast panels, aggregating approximately 6700 tons, were factory produced, trucked 117 miles to job site, and erected to form the walls, floors, and roofs of various types of buildings. Eight basic panels, utilizing a 4-ft module, are adapted to barracks, mess halls, warehouses, and various other occupancies. Average weight of about 38 psf for the 24-ft span panels is a factor in making transportation and production at a factory economical.

FOUR MILLION SQUARE FEET OF THIN-SHELL RIB PANELS FOR ROOF FRAMING 49-57

CHARLES C. ZOLLMAN — May 1953, pp. 809-824 (V. 49)

A detailed description of the required plant and the job planning for producing large numbers of identical precast concrete roof elements. These elements were used in 17 warehouses each 200 x 1000 ft. The initial contract required the production of 140 panels per day with a later additional contract calling for 132 panels per day.

Successive casting yard operations were release of side forms on previously cast panels; stripping and storing panels, cleaning molds; placing preassembled reinforcing cages; placing approximately 95 cu yd of concrete; vibrating, screeding, vacuum processing, and finishing of the concrete; curing; removal of spilled concrete; and washing and cleaning of vacuum mats and other equipment.

So effective was the prior planning and the setting up and operation of the casting yard that the only important interruptions to production were when the construction of cast-in-place rigid frames could not keep up to the supply of panels.

FABRICATION AND ERECTION OF PRECAST ENCLOSURE FRAMING FOR ONE-STORY BARRACKS 49-58

FORD J. TWAITS and MARTIN M. DENN — May 1953, pp. 825-832 (V. 49)

The construction of precast concrete barracks buildings for the United States Marine Corps artillery training facility on the desert near Twentynine Palms, Calif., is described. Thin-shell ribbed roof panels are manufactured in a central casting yard and wall panels are cast on the building floors. The wall panels are erected and plywood lined steel forms for cast-in-place rigid frames are attached. Roof panels are transported from the casting yard, set in position on the steel forms and the rigid frames are concreted.

CAREFUL PLANNING A NECESSITY IN BUILDING WITH PRECAST CONCRETE 49-59

BENTON H. PROCK — May 1953, pp. 833-840 (V. 49)

Any project involving large quantities of precast concrete elements must take into account planning, organization, equipment, and erection — all interrelated and dependent on each other for successful completion of the job. The most important phase of the whole operation is planning. Good engineering forethought that determines casting yard layout, sequence of operations, precasting and erection techniques, selection of equipment, and manpower organization prior to actual construction will lead to decreased operating costs.

CHEMICAL REACTIONS IN HIGH-PRESSURE STEAM CURING OF PORTLAND CEMENT PRODUCTS. . . . 49-60

W. C. HANSEN — May 1953, pp. 841-856 (V. 49)

A review of the literature on the chemical reactions in cement-silica pastes indicating the changes which may occur during the curing of portland cement concrete products at ordinary temperatures and at the elevated temperatures in steam curing. A bibliography lists the works reviewed.

PROPOSED MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE HIGHWAY STRUCTURES 49-61

COMMITTEE 315 — May 1953, pp. 857-860 (V. 49)

It is the purpose of the manual to present recommended methods of preparing drawings for the fabrication and placing of reinforcing steel in reinforced concrete highway structures. Typical drawings illustrate the use of the standard methods.

COMPACTING CONCRETE BY VIBRATION 49-62

H. S. MEISSNER — June 1953, pp. 885-892 (V. 49)

Vibration compaction is one of the important advancements in concrete technology. There yet remains, however, something to be learned about the fundamentals of vibration and the characteristics of vibrators to make more efficient use of this method for compacting concrete. A description and classification is given of the various vibrators in use together with some discussion of their characteristics and the type of work for which they are adapted.

LABORATORY TESTS ON VIBRATION OF CONCRETE 49-63

SVEN G. BERGSTROM — June 1953, pp. 893-908 (V. 49)

A brief survey of tests dealing with pressures, displacements, and energy consumption in fresh concrete compacted by internal vibration. Three methods of determining the radius of action of the internal vibrator and the effects of variation in the radius of action with the concrete mix and with the vibrator characteristics are discussed. A graph presents some data on the energy consumption during vibration. Described is an apparatus for studying variations in the properties of fresh concrete with time of vibration. The type of these variations characterizes the fresh concrete in respect to

required time of vibration and liability to segregation. Mention is made of a few test results concerning the relation between properties of hardened concrete and time of vibration.

EFFECT OF VIBRATION ON AIR CONTENT OF MASS CONCRETE....49-64

WALTER O. CRAWLEY — June 1953, pp. 909-920 (V. 49)

Tests were made to observe the effect of high-frequency (13,000 vpm) and moderate-frequency (6800 vpm) vibration on concrete ranging from ½- to 4-in. slump, containing 6-in. coarse aggregate, and having nominal air contents of 3, 6, and 9 percent in that portion of the mix smaller than the 1½-in. sieve. Cores drilled from hardened specimens of the concrete with 6 percent air content were examined micrometrically for amount and distribution of air and coarse aggregate.

The high-frequency vibrator was found to cause more rapid loss of entrained air than the moderate-frequency vibrator. However, either vibrator could cause a 50 percent loss in air from nominal 3 percent-air-content concrete in 30 sec. The rate at which air was lost generally increased with slump, but not to a marked degree. The high-frequency vibrator had more effect in causing movement and escape of air, while the moderate-frequency vibrator caused more movement and segregation of the coarse aggregate.

VIBRATION OF MASS CONCRETE...49-65

LEWIS H. TUTHILL — June 1953, pp. 921-932 (V. 49)

Vibration has already done much to improve the quality of mass concrete. It has completely changed our concept of what is practical and desirable as a mass-concrete mix. Together with air entrainment it has made mixes of low cement content placeable with reductions in unit water content up to 80 lb per cu yd. Other improvements in quality or in costs, or both, can result when full advantage of vibration is taken to place mixes with larger aggregate in many cases where there is reinforcing, to place concrete in thicker layers, to permit use of larger buckets, and to eliminate poor bond at cold joints.

APPLICATION OF VIBRATION TO CONCRETE PAVEMENT CONSTRUCTION 49-66

A. G. TIMMS — June 1953, pp. 933-944 (V. 49)

Brief description and summary of tests and experience in the United States and Europe in vibrating pavement concrete. Effect of vibration on tolerances in composition of the fresh concrete, gradation of coarse aggregate, and maintaining line and grade of forms are factors in the development of adequate vibration equipment.

VIBRATION PRACTICES IN PIPE, PRECAST, AND BLOCK MANUFACTURE 49-67

GEORGE W. WASHA — June 1953, pp. 945-952 (V. 49)

The discussion of this broad topic is confined to statements regarding present practices. No attempt has been made in this highly competitive and controversial field to indicate superiority of one method or process over another. Obviously it has not been possible to describe all processes in use at the present time.

VIBRATION PRACTICES IN STRUCTURAL WORK 49-68

JOHN H. BANKER — June 1953, pp. 953-956 (V. 49)

This paper is concerned with the operation of vibrators in the field. In discussing vibration, it is difficult to isolate it from the operation of placing concrete — they must go hand in hand. Placing and vibrating concrete in walls is given special emphasis.

Proceedings V. 50

MINIMUM STANDARD REQUIREMENTS FOR PRECAST CONCRETE FLOOR UNITS (ACI 711-53) 50-1

COMMITTEE 711 — Sept. 1953, pp. 1-16 (V. 50)

Supersedes 43-6
Superseded by 55-4

These minimum standard requirements for precast concrete floor units are to be used as supplements to ACI "Building Code Requirements for Reinforced Concrete (ACI 318-51)." These standard requirements cover five different types of precast concrete floor units: (1) I-beam type, with either cast-in-place or precast slab; (2) hollow core type; (3) assembled concrete block type; (4) precast inverted T-beam joist with precast filler block between; and (5) integrally precast slab and T-joist. An appendix contains applicable sections of the ACI Code (ACI 318-51).

CONCRETE FOR RADIATION SHIELDING 50-2

EDWIN J. CALLAN — Sept. 1953, pp. 17-44 (V. 50)

Concrete for shielding nuclear radiation is discussed, with emphasis on factors related to concrete technology and cost. The mechanics of radiation shielding is presented briefly, and data regarding concrete for shielding are reviewed. Tables and curves of concrete thickness required for shielding are given for both ordinary and heavy concrete. Problems involved in the use of special concrete are discussed. An outline of a procedure for designing concrete shielding is presented.

ABSORPTION BY CONCRETE OF X-RAYS AND GAMMA RAYS 50-3

B. E. FOSTER — Sept. 1953, pp. 45-64 (V. 50)

The mechanism of the absorption of x-rays and gamma rays by various shielding materials is discussed. A review of the experimental work performed by the National Bureau of Standards to establish data with which concrete barriers may be designed is presented. A brief discussion of the methods used in protective barrier design is included and the relative merit of several barrier materials, including heavy concretes, is discussed.

EFFECT OF SUSTAINED OVERLOAD ON THE STRENGTH AND PLASTIC FLOW OF REINFORCED CONCRETE BEAMS 50-4

G. W. WASHA and P. G. FLUCK — Sept. 1953, pp. 65-72 (V. 50)

Research on the plastic flow of reinforced concrete beams has been in progress at the University of Wisconsin since 1941. Results of several past programs have been previously reported, and additional programs are now in progress. This paper presents the test results obtained from overload tests of beams which had previously been subjected to a 3-year period of sustained design load. Eighteen beams were tested, involving three conditions of reinforcement in each of three different sizes. The control beam of each pair was tested for an hour during which the uniform load was increased in increments until the ultimate load was reached. The other beam of each pair was subjected to a high and periodically increased overload for about 1 year and was then loaded to ultimate.

The beams subjected to the high sustained overload suffered considerable plastic flow, but the ultimate strength was not appreciably different from that of companion control beams.

ECONOMICAL DESIGN OF PRESTRESSED CONCRETE BEAMS 50-5

DAVID P. BILLINGTON — Sept. 1953, pp. 73-88 (V. 50)

The ability of simply supported post-tensioned concrete beams to span more than 150 ft makes it important that such members be designed for maximum economy. This paper shows the effects of varying the cross-sectional shape and size on the load capacity of any form

of post-tensioned beam. The parts of the cross section above and below the center of gravity of the entire concrete section are analyzed separately.

PROPOSED RECOMMENDED PRACTICE FOR SELECTING PROPORTIONS FOR CONCRETE 50-6

COMMITTEE 613 — Oct. 1953, pp. 105-120 (V. 50)

Superseded by 51-2

The proportioning of concrete, including mixes containing entrained air, is set forth in this recommended practice. Tables are provided which, along with laboratory tests on physical properties of fine and coarse aggregates, yield information rapidly for obtaining concrete proportions. Three examples are included in the proportioning of air-entrained and non-air-entrained mixes which use the tables. Correction of aggregate proportions due to moisture present in aggregates is illustrated. Laboratory tests are given in the appendix and include those on physical properties of cement and aggregate. Also included is a simple method of obtaining mix proportions for the small job.

DEVELOPMENT OF A CELL FOR THE INSTALLATION OF ELECTRICAL RESISTANCE STRAIN GAGES IN CONCRETE 50-7

HERBERT E. WORLEY and RICHARD C. MEYER — Oct. 1953, pp. 121-136 (V. 50)

These investigations were conducted to develop a method of adapting SR-4 electrical resistance strain gages for measurement of strains in concrete pavements. Previous experiments in which SR-4 gages were incorporated in cells which could be cast internally in concrete indicated that some new waterproofing technique would have to be found which would extend the useful life of such installations.

SR-4 gages having a 6-in. gage length were found to indicate strain values which were much more consistent than did shorter gage lengths when used on concrete containing coarse aggregate.

A number of experimental cells were made and tested before one was developed that measured strains satisfactorily. Th SR-4 gages for this gage cell were cemented between the flattened walls of an expanded portion of 5/32- or 3/16-in. copper tubing. The copper tubing extended the length of the gage leads and was filled with Petrosene wax to keep moisture from entering the gage cell.

Specimens in which these thin-walled copper gage cells were cast were tested in the laboratory in compression and in flexure. Strains measured with internal gages compared favorably with those found by similar surface gages with no apparent reinforcing of the concrete by the gage cells. Consistency of strain values indicate a good bond between concrete and gage cell. Two rosettes of two gages each were cast in a pavement and a strain investigation was made to determine the workability of these gages. Strains due to a 20,000-lb axle moving load at various speeds and in several wheel lanes were recorded satisfactorily.

After having been installed in a concrete pavement for 10 months the gages manifested no decrease in gage cell resistance. It is believed that gages of this type are waterproof and will remain serviceable for a long time.

FAILURE OF CONCRETE UNDER COMBINED TENSILE AND COMPRESSIVE STRESSES 50-8

G. M. SMITH — Oct. 1953, pp. 137-140 (V. 50)

Experimental data are presented on failure of concrete under combined tensile and compressive stresses. A simple stress-ratio equation, based on ultimate compressive strength and modulus of rupture, shows a remarkable correlation with experimental data for various combinations of tensile and compressive stresses.

CORRELATION BETWEEN LABORATORY ACCELERATED FREEZING AND THAWING AND WEATHERING AT TREAT ISLAND, MAINE 50-9

THOMAS B. KENNEDY and KATHARINE MATHER — Oct. 1953, pp. 141-172 (V. 50)

Six coarse and eight fine aggregates were used in 48 combinations to make concrete specimens, all with the same water-cement ratio, air content, and slump for comparative testing in accelerated freezing and thawing and exposure to natural weathering at mean-tide elevation at Treat Island, Me.

The two types of exposure, aggregates used, test procedures, and results of dynamic testing of concrete specimens in both exposures are described. A summary is included of the examination of some of the concrete specimens and hypotheses suggested to explain differences in results in the two exposures, and a discussion of the relation of difference between thermal coefficients of coarse aggregate and mortar and durability factor found in these tests. The appendix contains more detailed information on the examination of the concrete and related discussion of other factors believed to be important in explaining results.

Comparison of laboratory and field results indicates that each aggregate combination behaves in an individual manner in each exposure, as influenced by differences in materials and in exposures. Prediction of behavior in one type of exposure from behavior in another cannot be made unless all the differences between the two can fully be evaluated, which is not yet possible.

SHEARING STRENGTH OF REINFORCED CONCRETE COLUMN FOOTINGS . . . 50-10

EIVIND HOGNESTAD — Nov. 1953, pp. 189-208 (V. 50)

A re-evaluation of F. E. Richart's tests of column footings reported in 1948 shows that the use of present design methods, involving a shearing stress at a distance d around the column perimeter, does not lead to a consistent factor of safety with respect to shearing failures. A shearing stress at a distance zero around the column was found to be a better measure of shearing strength. The ultimate value of this stress is given as a function of concrete strength and the relative intensity of flexural loading combined with the shearing force. On this basis a new design method is suggested with respect to the shearing strength of column footings.

SELECTION AND DESIGN OF PRESTRESSED CONCRETE BEAM SECTIONS 50-11

T. Y. LIN and A. C. SCORDELIS — Nov. 1953, pp. 209-224 (V. 50)

The basic concept of the action of an internal bending couple in a prestressed concrete beam as compared to that in a conventional reinforced concrete beam is introduced. Using this concept, criteria for the selection of shapes and formulas for the design of sections are developed. Tables giving design constants are listed for various common beam sections. Relative advantages and disadvantages of different types of cross sections are discussed. Using the method developed, an example beam section is designed.

RELATION OF SHRINKAGE TO MOISTURE CONTENT IN CONCRETE BLOCK 50-12

GEORGE L. KALOUSEK, RICHARD J. O'HEIR, KENNETH L. ZIEMS, and EDWIN L. SAXER — Nov. 1953, pp. 225-240 (V. 50)

Six types of aggregates and five curing methods used in commercial block production were used for shrinkage studies and strength determinations of concrete masonry units. Shrinkage and moisture loss were determined at 73 ± 3 F in a cycle consisting of exposure to air at 25 percent relative humidity, immersion in water, exposure to air at 70 percent relative humidity, followed by exposure to air at 25 percent relative humidity.

Autoclaved products underwent about half the shrinkage shown by units cured by other methods. Curing with steam at atmospheric pressure up to 170 F or

moist air at 73 F tended to give the same results for each aggregate. Sand and gravel units shrank the least; cinders, expanded shale, expanded slag, and sintered shale gave similar results which were somewhat higher than that for sand and gravel. Pumice units showed slightly higher shrinkage than the latter group.

The data show that a 40 percent moisture loss does not generally represent more than about 20 to 50 percent of potential shrinkage occurring at 25 percent relative humidity.

TORSIONAL RIGIDITY OF RECTANGULAR SLABS 50-13

KURT H. GERSTLE and RAY W. CLOUGH — Nov. 1953, pp. 241-248 (V. 50)

Analysis of many three-dimensional monolithic structures requires information as to the torsional rigidity of the elements of which they are constructed. Because of rigid connections at the ends, warping of the members is restricted and bending stresses are induced with the torsion. For this reason, the elementary theory of torsion cannot be applied.

In this paper the effect of end restraint on the torsional rigidity of rectangular slabs has been analyzed. The magnitude of the stiffening effect is found to vary with the length-width ratio of the slab. For square slabs, end fixity increases the rigidity by 80 percent. Even for slabs with length-width ratios of 6, the rigidity is increased by 8 percent. Experimental data are also presented, showing good agreement with the analytical results.

DETERMINATION OF SETTING AND HARDENING TIME OF HIGH-ALUMINA CEMENTS BY ELECTRICAL RESISTANCE TECHNIQUES 50-14

J. CALLEJA — Nov. 1953, pp. 249-256 (V. 50)

Using electrical resistance techniques developed by the author for determining the setting time of cement pastes, differences in the behavior of high-alumina and portland cements are established experimentally. These techniques are based on variations in electrical resistance of cement pastes during setting.

Experimental results indicate that this method cannot be applied to high-alumina cements in the same manner as used for portland cements, due to probably a partial overlapping of setting and hardening processes in high-alumina cements.

PIER 57 CONCRETED THROUGH THE WINTER 50-15

M. D. MORRIS — Dec. 1953, pp. 281-284 (V. 50)

Although much has been written about New York's Pier 57 and the new techniques used in its construction, little has been said about the fact that through 5 months from November, 1951, through March, 1952, regardless of near zero temperatures, concrete was placed at 60 F and steam cured with no loss of time or ultimate strength. This brief description of this work is not posed as a standard text on the subject of winter concreting but is submitted as a record of how one job was done successfully.

FACTORS INFLUENCING THE STRENGTH OF CONCRETE AS REVEALED BY A SIX-YEAR RECORD OF CONCRETE CONTROL 50-16

J. J. WADDELL — Dec. 1953, pp. 285-296 (V. 50)

Presents a summary of 6 years of concrete control data for the Friant-Kern canal and distribution systems for the Bureau of Reclamation's Central Valley Project in California. The period covered is from June, 1946, to June, 1952. Several relationships between the different qualities of the concrete have been plotted, disclosing both an over-all trend and a cyclic variation. Partial explanation has been made or the trends and cycles, but some of the causes are obscure and defy indentification.

LIMIT ANALYSIS AND DESIGN 50-17

WILLIAM PRAGER — Dec. 1953, pp. 297-304 (V. 50)

Many problems concerning limit analysis and limit design of reinforced concrete beams and frames can be treated geometrically in terms of the safe domain in load space. The procedure is illustrated by a typical example involving a frame.

FLOOR AGGREGATES 50-18

E. W. SCRIPTURE, JR., S. W. BENEDICT, and D. E. BRYANT — Dec. 1953, pp. 305-316 (V. 50)

An investigation was undertaken to evaluate the influence of different aggregates on the wear resistance of concrete floors. Three types of mixes were used: one with ¾-in. aggregate, representing a monolithic floor; one with ⅜-in. aggregate, representing a two-course floor; and one with a fine aggregate, used as a dust coat. Ten different mineral and ground-iron aggregates were tested. An attempt was made to keep all variables except aggregates constant. These included workability, compressive strength, and method of finishing. Abrasion tests indicated that the relative hardness of mineral aggregates was not directly related to the wear resistance of the floor, or at least had comparatively little influence on this property. Similarly, the method of finishing, within the limits of the types of finishing used in this investigation, was only significant to a small degree. With a malleable-iron aggregate, however, marked differences in wear resistance from that observed with mineral aggregates were found.

VALIDITY OF CERTAIN ASSUMPTIONS IN THE MECHANICS OF PRESTRESSED CONCRETE 50-19

GROVER L. ROGERS — Dec. 1953, pp. 317-332 (V. 50)

Validity of certain assumptions of structural mechanics applicable to the analysis of prestressed concrete structures is discussed. Results of field tests conducted in France indicate that the calculated load causing the first tensile crack (based on ordinary elasticity theory) in a prestressed concrete slab may be only one-fifth to one-sixth the actual load. This difference has been accredited to the inapplicability of the assumptions of isotropy, homogeneity, and elasticity as employed in the theory of elasticity to prestressed concrete slabs. As a result of these tests new concepts have been suggested as a possible basis for a more realistic theory.

Analytical and experimental results of a test conducted on a laboratory model of a slab prestressed in two directions show that the assumptions and use of the theory of elasticity are indeed adequate. The load causing the first tensile crack was found to be within a few percent of the load predicted using elastic theory. Such agreement indicates that the discrepancies between theory and practice must be attributed to other causes rather than inherent errors in the theory of elasticity.

EFFECT OF AGE OF CONCRETE ON ITS RESISTANCE TO SCALING CAUSED BY USING CALCIUM CHLORIDE FOR ICE REMOVAL 50-20

W. C. HANSEN — Jan. 1954, pp. 341-352 (V. 50)

Tests were made in the field to determine the effect of age of concrete, at the time of the first application of deicing salt, on the resistance to frost and salt action. Slab specimens, 36 x 36 x 6 in., were provided with dikes which permitted the freezing of approximately ⅜ in. of water on their surfaces. Specimens were made with Types I and IA cements and a blend of the two cements, which yielded concretes having air contents of approximately 1.5, 3.0, and 5.0 percent. Ice was removed by applications of flake calcium chloride whenever the ⅜ in. of water was frozen solid. A total of 55 cycles of freezing and thawing were obtained in the one winter.

Except for the specimens which were 117 and 91 days, respectively, at the first freeze, those made with concrete containing approximately 1.5 percent air were completely scaled in from 5 to 15 cycles of freezing and thawing. Complete scaling was obtained in less than 55 cycles of freezing and thawing with the concrete containing approximately 3 percent air only on specimens which were 29 days or less old at the time of the

first freeze, and with concrete containing approximately 5 percent air only on specimens which were 8 days or less old at the first freeze.

CORRUGATED BOX FORMS FOR CONCRETE RIBBED-SLAB CONSTRUCTION 50-21

H. C. PFANNKUCHE — Jan. 1954, pp. 353-356 (V. 50)

Describes application of corrugated box form to pan construction and to slab on ground structures. Cost data are included.

STRAP STEEL FOR PRESTRESSED CONCRETE STRUCTURES 50-22

K. P. MILBRADT — Jan. 1954, pp. 357-364 (V. 50)

A new type of prestressing steel — strap steel — is introduced as offering possible economy for this type of construction. Tempered spring steel, 0.048 x 0.625 in., having an average ultimate strength of 215,000 psi and a yield strength of 185,000 psi was used. Economical prestressing clamps were developed. This type of prestressing was then applied to a test beam.

Specific conclusions from the test were: (1) the strap was easily handled, placed, clamped, and stressed either singly or multiply in one operation; (2) bond was sufficient to transfer the prestressing force; and (3) ultimate load deflection for the test beam was obtained with little elongation of the steel.

STUDIES ON THE CEMENTITIOUS PHASES OF AUTOCLAVED CONCRETE PRODUCTS MADE OF DIFFERENT RAW MATERIALS 50-23

GEORGE L. KALOUSEK — Jan. 1954, pp. 365-380 (V. 50)

Physical tests on sand and gravel units made with different constant-weight mixtures of lime and cement in fixed proportions to the aggregate indicated that strength was directly proportional to unit weight of the raw block. At any given density, strength was largely independent of the cement to lime ratio. Cement generally increased the densities more than did the lime and, therefore, generally showed better strengths. Drying shrinkage appeared to be independent of the lime-cement proportions in sand and gravel units.

In chemical tests using aggregate fines, compositions of autoclaved lime cement silica (quartz) solids ranged in composition from about 0.9 to 1.3 mols of CaO per mol of SiO_2 (C/S ratio) providing that silica was present in a sufficient amount. Solids made from mixtures deficient in silica contained, in addition to the 1.3 C/S hydrate of the 0.9-1.3 C/S series, a poorly crystallized form of alpha-type dicalcium silicates hydrate. Reaction solids made with pumice and shale also approached low-lime compositions of about 1.0 C/S. Structure-wise these products are closely related to 0.9 to 1.3 C/S series made with silica fines, but extended in composition to values as high as about 1.5 C/S. These, and the phases which extended in composition above a 2.0 C/S ratio, did not undergo any apparent recrystallization to the alpha-type hydrate. Differential thermal analysis, in conjunction with chemical analyses, made it possible to differentiate between solids phases of different C/S ratios made of a given aggregate, or products of a given C/S ratio (from about 0.9 to about 1.3) made with different aggregates.

PROPERTIES OF CONCRETE AND THEIR INFLUENCE ON PRESTRESS DESIGN 50-24

RAYMOND E. DAVIS and G. E. TROXELL — Jan. 1954, pp. 381-392 (V. 50)

Of the various properties of concrete that have to be taken into consideration in prestress design, there are three that merit special attention: (1) the necessity for uniformity of quality of concrete throughout a prestressed member, (2) the desirability of employing a concrete for which the drying shrinkage will be low, and (3) the desirability of employing a concrete for which the creep under the action of prestress will be low. Factors which influence the degree of uniformity and magnitude of drying shrinkage and creep are discussed and suggestions made concerning the use of materials and practices which may be expected to lead to most favorable results.

To secure uniformity, there is required a concrete mix that is more than ordinarily plastic and sticky, and which when vibrated will flow readily into place without segregation and bleeding. Close job control is required with respect to grading of materials, batching, use of admixtures, mixing, transporting, and placing.

Other things being equal, within the ordinary range of richnesses of mix, drying shrinkage of concrete is nearly proportional to the quantity of mixing water employed, creep is proportional to the quantity of hardened cement paste and the water-cement ratio. To keep these effects at a minimum, it is desirable that the paste content be the minimum and the water-cement ratio be the minimum which will produce a fresh concrete of the desired properties and a hardened concrete of the desired strength. Additional factors affecting shrinkage and creep include cement composition; grading, maximum size, and character of aggregates; admixtures (affecting uniformity as well as shrinkage); size of prestressed members; and others.

A STORY OF PROGRESS — FIFTY YEARS OF THE AMERICAN CONCRETE INSTITUTE 50-25

WILLIAM A. MAPLES and ROBERT E. WILDE — Feb. 1954, pp. 409-436 (V. 50)

A brief account of 50 years of significant administrative and technical developments of the American Concrete Institute. It summarizes changing emphasis on various aspects of concrete engendered by technical, economic and political events and trends over the past half century.

FIFTY YEARS OF DEVELOPMENT IN BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE. 50-26

FRANK KEREKES and HAROLD B. REID, JR. — Feb. 1954, pp. 441-472 (V. 50)

Traces 50 years of development in building code requirements for reinforced concrete to provide present users of the ACI Building Code with background information on the evolution of many provisions dealing with design of principal structural elements of a reinforced concrete building. Starting with the formation of the first Joint Committee on Reinforced Concrete in 1904, research and design development and philosophy are reviewed — which culminated in the present ACI Building Code.

HISTORY AND DEVELOPMENT OF PRECAST CONCRETE IN THE UNITED STATES 50-27

J. L. PETERSON — Feb. 1954, pp. 477-496 (V. 50)

Some of the first uses of precast concrete are described. Early designers used precast concrete for reasons of safety, economy, and savings in time of construction. Descriptions of projects built before 1920 which used precast concrete units weighing up to 75 tons are given. Development of the use of precast concrete for bridges, buildings, and marine construction is described. Introduction of modern methods of prestressed concrete and lift-slab concrete construction is discussed. Future development of precast concrete is predicted.

EVOLUTION OF CONCRETE CONSTRUCTION 50-28

ROGER H. CORBETTA — Feb. 1954, pp. 501-512 (V. 50)

Evolution of the concrete construction industry can be traced by the improvement in materials, construction techniques, and equipment. Rising costs and efficiency have dictated innovations in concrete construction such as prestressed, tilt up, and lift slab. Each of these, or combinations such as precast prestressed units, have figured prominently costwise and resulted in increasing popular acceptance of concrete construction in these highly competitive times. Equipment has been improved along with new developments in materials and construction techniques, and has stimulated contractors to adopt improved methods of concrete construction.

HOWARD F. PECKWORTH — Feb. 1954, pp. 513-524 (V. 50)

An outline of the broader technical developments in the concrete pipe industry over the past 50 years, including manufacturing processes such as hand tamping, mechanical tamping, packing with the packerhead, casting with variations of vibration and vacuum processes, centrifugating, pounding or rolling, and variations such as tamping with vibration, or centrifugation with rolling and vibration. These technical improvements have resulted in a product characterized by thin walls, high strength, and long life.

OTTO SAFIR — Mar. 1954, pp. 525-532 (V. 50)

Structural requirements, system used, and details for a 130-ft precast clear-span hanger, 160 ft long, are described. An unusual requirement was that the whole of the superstructure could be disassembled and re-erected at a different location. This led to the adoption of a structural system utilizing bents made up of precast members. Important structural details, method of erection, and full scale test loading data on one bent are also considered in addition to cost figures for the structure.

JAMES S. BLACKMAN — Mar. 1954, pp. 533-544 (V. 50)

Method for determining the original water content of concrete, at the time of hardening, is presented along with the influence of time-temperature conditions of dehydration, character of aggregate, and age and exposure of concrete on the method. Conclusions drawn show that (a) water content at the time of hardening can be determined satisfactorily, after saturation by a 24-hr immersion, by dehydration at 1100 F for 2 hr, (b) composition of aggregate may affect results of volatilization of aggregate constituents occurs, and (c) age and exposure conditions of concrete specimens do not appear to affect test results. Sample computations for age and aggregate series of tests are included in an appendix.

JOSEPH PENZIEN and ROBERT J. HANSEN — Mar. 1954, pp. 545-568 (V. 50)

Laboratory investigations of static and dynamic elastic behavior of reinforced concrete beams are described. Results indicate that strains of concrete and steel may be predicted with reasonable accuracy for both static and dynamic conditions of loading provided that (a) proper allowance is made for the effects of creep and cracking of the concrete, and (b) that an exact dynamic theory be used with allowance for damping for the dynamic condition of loading.

C. S. HALE, R. E. GLOVER, P. W. TERRELL, and W. P. SIMMONS, JR. — Mar. 1954, pp. 573-584 (V. 50)

Surging in concrete pipe systems preventing or delaying delivery of irrigation water necessitated field and laboratory studies to determine the cause and provide a means of control. The studies show how surging can be controlled by the creation of a system out of resonance, thus holding surge amplitudes within tolerable limits.

FRED E. KOEBEL — Mar. 1954, pp. 585-596 (V. 50)

Preliminary tests were performed on beams cast from lightweight expanded-shale concrete to determine the applicability of this type of aggregate for prestressing. Tests were also made on similar beams with grouted and nongrouted prestressing steel. Results are plotted in graphical form and conclusions drawn from test results are presented.

HENRY L. KENNEDY — Apr. 1954, pp. 617-624 (V. 50)

Retiring ACI President Kennedy reviews the year's activities and new fields of endeavor for the Institute are introduced. It is emphasized that through an extension of ACI's services and contributions to the industry, the Institute's future growth and development is assured.

NORMAN P. MASON — Apr. 1954, pp. 625-632 (V. 50)

Five basic factors to be appraised in determining the concrete industry's 1954 activity are reviewed. These include governmental actions, financing, industry public relations, competition, and development and research. Each of these basic factors will affect the working out of the basic economic laws during the coming year. The construction market for 1954 is viewed optimistically.

J. F. JELLEY — Apr. 1954, pp. 633-636 (V. 50)

Responsibility of the engineer in the selection of the most economical, the most efficient, and the most suitable material of construction is reviewed. Keener competition between various construction materials will provide the concrete industry with the incentive to develop new techniques, as well as to insure the quality of concrete.

W. A. DEXHEIMER — Apr. 1954, pp. 637-644 (V. 50)

As the Bureau of Reclamation's principal construction material, concrete of good quality is of more than academic concern to the USBR. The use of concrete by the Bureau is reviewed. Inspection practices and specifications are covered briefly, and some of the Bureau's work in concrete research is described.

S. D. STURGIS, JR. — Apr. 1954, pp. 645-656 (V. 50)

The Corps of Engineers' construction program is so extensive and varied that a summary of the Corps' use of concrete provides a fair cross section of the position of concrete in the heavy construction industry. The civil and military works program is reviewed. As part of its design and specification work the Corps has done considerable development work on concrete and these studies are enumerated briefly.

J. J. HAMMOND — Apr. 1954, pp. 657-668 (V. 50)

With the accumulation of considerable data on the behavior of concrete dams by the Bureau of Reclamation, it was thought current design practices might be revised to permit more rational design with attendant economy. Accordingly, a Bureau committee analyzed: (1) forces that act on gravity and arch dams to promote instability or structural failure, (2) resisting forces which promote stability or structural competency, (3) meaning and measurement of factor of safety, and (4) requisite strengths of materials and foundations and methods of measurement.

Analyses disclosed that gravity and arch dam design may be made more rational by the adoption of uniform and consistent procedure, and the full utilization of data from analytical procedures, laboratory investigations, and measurements of the behavior of structures in service. Design criteria, derived from these investigations, for concrete arch and gravity dams are included.

RAPID DESIGN OF CONTINUOUS PRESTRESSED MEMBERS 50-41

E. I. FIESENHEISER — Apr. 1954, pp. 669-676 (V. 50)

Advantages of prestressing combined with continuity are emphasized and fixed-end moment formulas for various conditions of prestressing may help to make the combination feasible. Line of thrust and kern boundary concepts are advocated for use in design and their use is illustrated in an example of a three-span continuous beam structure.

DESIGN OF CONCRETE MIXES FOR VACUUM PROCESSING 50-42

JOHN G. DEMPSEY — Apr. 1954, pp. 677-688 (V. 50)

Results of applying the vacuum process to field and laboratory mixes are analyzed with respect to the workability and strength, and an inquiry is made into the apparent relationship between vacuum process slabs and specialized vacuum cylinders made from the same batch. The effect of the vacuum process on the water-cement ratio is discussed and a method of designing concrete mixes so as to protect the final yield of the concrete and secure full benefits of the system is proposed.

COMBINED FORM AND REINFORCEMENT FOR CONCRETE SLABS 50-43

BENGT F. FRIBERG — May 1954, pp. 697-716 (V. 50)

One-way concrete slab construction, designated as "re-form," is described in which high-strength galvanized corrugated steel is both form and reinforcement for the concrete, and in which temperature reinforcement, welded to the corrugated steel, performs shear transfer. Structural tests are described and analyzed. Suggestions are given for moment distribution in slabs cracked over the supports in continuous spans. Long-time deflections of thin slabs are appraised. Design procedures and applications for re-form construction are indicated.

NATURE OF BOND IN PRETENSIONED PRESTRESSED CONCRETE .50-44

JACK R. JANNEY — May 1954, pp. 717-736 (V. 50)

Methods and findings of an investigation of bond in pretensioned prestressed concrete members are discussed. Two types of tests were involved. Bond near the ends of a prestressed member after release of the wire prestress was studied using prismatic specimens. Beam specimens were used to study flexural bond and the interrelation between this flexural bond and the bond resulting from the transfer of prestress. Principal variables considered were diameter, surface condition, and the degree of pretension of the wire reinforcement.

A variation in anchorage length and general shape of the stress transfer distribution was noted for wires of different diameters and for different surface conditions ranging from rusted to lubricated. Similar observations were observed when the pretensioned steel was released to concretes of different strengths. An elastic analysis of the deformations occuring when pretensioned steel is released confirms the test results in suggesting that the prestress transfer bond is largely a result of friction between concrete and steel.

Beam tests indicate that reliable values for flexural bond stress after cracking are not obtained by the expression generally accepted for calculation of bond stress. High bond stresses develop only after cracking has occurred. Consequently, if loss of bond is the cause of beam failure, a prestressed beam will carry a greater ultimate load than an unprestressed beam reinforced with the same steel.

PRACTICAL ASPECTS OF PLANT PRODUCED PRESTRESSED CONCRETE .50-45

ORLEY O. PHILLIPS — May 1954, pp. 737-740 (V. 50)

Development of plant for mass production of pretension concrete units is described. Versatility and speed of production are essential. Importance of close coordination of engineering planning, design, and details of prestressed members with the manufacture, handling, and erection is emphasized. Costs of prestress construction are included.

VOID SPACING AS A BASIS FOR PRODUCING AIR-ENTRAINED CONCRETE .50-46

T. C. POWERS — May 1954, pp. 741-760 (V. 50)

Basic studies show that the function of entrained air is to protect the paste and that the effectiveness depends on the distance from void to void in the paste. Freezing and thawing tests show different mixes have nearly equal frost resistance when the spacing factor is about 0.01 in. The amount of air required for a given spacing factor is directly proportional to the paste content and is greater the smaller the specific surface of the air voids.

The void system is made up of relatively coarse natural voids and entrained bubbles. Characteristics of natural voids vary with aggregate grading, consistency, and other mix characteristics. With a given amount of air-entraining agent in the mixing water, the amount of entrained bubbles is smaller the greater the quantity of cement or other fine solids in the water.

A procedure is suggested for designing a fixed spacing factor where such procedure is economically feasible.

CRUSHED STONE PRODUCTION. . . .50-47

A. T. GOLDBECK — May 1954, pp. 761-772 (V. 50)

Prospecting for and production of commercial crushed stone are detailed with emphasis on modern trends in the crushed stone industry. Quarrying, transportation of quarried stone, crushing, screening, washing, production of stone sand, and related operations are described as to equipment, methods, and trends. A selected bibliography of 71 references completes the report.

CELLULAR CONCRETES

PART 1 . . . . .50-48a

RUDOLPH C. VALORE, JR. — May 1954, pp. 773-796 (V. 50)

PART 2 . . . . .50-48b

RUDOLPH C. VALORE, JR. — JUNE 1954, pp. 817-836 (V. 50)

A review is given of method of preparation and physical properties of moist- and high-pressure steam-cured cellular concretes, ranging in density from 10 to 100 lb per cu ft, as they have evolved in Europe in the past 30 years. Data are given for Swedish, Danish, Russian, German, British, and Belgian materials, and for experimental mixtures prepared at the National Bureau of Standards. The most economical and controllable cell-forming process, which is preformed foaming, employs hydrolyzed protein foaming agent. Aluminum powder and hydrogen peroxide gas-forming processes and the excess water process are also described.

Moist-cured materials contain portland cement, neat or with sand; they are used as insulation, roof or floor fills, and for fire protection. Cellular neat cement has adequate strength for structural use at densities above 40 lb per cu ft but the linear drying shrinkage ranges from 0.3 to 0.6 percent. Cement-sand mixtures have lower strength, higher shrinkage, and higher absorption than lightweight aggregate concretes of comparable density.

Autoclaved materials contain portland cement or lime and finely divided siliceous materials such as ground sand, fly ash, and burned oil shale. Ratios of binder to "pozzolan" range from 1:0.5 to 1:4 for cement and 1:1 to 1:6 for lime, depending on fineness and composition of the binder and siliceous material.

Compressive strengths were 250 to 1000 psi at 30 lb per cu ft, 400 to 2000 psi at 40 lb per cu ft, and 800 to 3000 psi at 50 lb per cu ft. Flexual strengths were 1/5 to 1/3 of the compressive strength. Drying shrinkages ranged from 0.01 to 0.10 percent. Water absorptions were 20 to 50 percent by volume. Elasticity, thermal expansion, fire resistance, and acoustic properties are also discussed.

Thermal conductivity data from various sources are in good agreement and are a function of density from 10 to 70 lb per cu ft, regardless of composition, cell-forming process, or curing.

FLEXURAL STRENGTH OF PRESTRESSED CONCRETE BEAMS 50-49

D. F. BILLET and J. H. APPLETON — June 1954, pp. 837-856 (V. 50)

Analytical and experimental studies on behavior and ultimate flexural strength of post-tensioned, end-anchored, bonded, prestressed concrete beams are reported. A rational analysis is developed for computing ultimate moment and steel stress at failure. Approximate expressions are given for computing ultimate steel stress for cases when the stress-strain curve for the steel reinforcement may be approximated by two straight lines.

Results of tests on 26 rectangular prestressed concrete beams are presented. The effect of major variables — percentage of steel, amount of prestress, and concrete strength — on deflections, cracking loads, and ultimate loads are studied.

Twenty-one beams failed in flexure, either by crushing of concrete after excessive elongation of reinforcement or by crushing of concrete while steel stress was in the elastic range. Three beams were nearly balanced between shear and flexural failure, and two beams failed initially in bond. Comparisons of actual ultimate moments with those computed by analytical expressions show good agreement.

PERLITE INSULATING CONCRETE . . . 50-50

J. JOHN BROUK — June 1954, pp. 857-868 (V. 50)

Production, properties, and applications of perlite insulating concrete are described including mining and manufacture of perlite aggregate, variation in different deposite, basic cost data, physical properties of perlite concrete, and significance of aggregate hardness. The basic "1:6 mix" for perlite insulating concrete, and job recommendations for this mix, covering roof decks and roof fills are detailed. Examples of use of perlite in insulating roof decks and roof fills and other applications are included.

MINIMUM BAR SPACING AS A FUNCTION OF BOND AND SHEAR STRENGTH 50-51

PHIL M. FERGUSON, ROBERT D. TURPIN, and J. NEILS THOMPSON — June 1954, pp. 869-888 (V. 50)

Results of investigations to establish minimum allowable bar spacings in reinforced concrete members are reported. This required considerable study on what bond strengths could be developed without any special provisions against splitting from the action of radial forces induced in the concrete by the inclined compressive forces set up by bearing of the lugs of deformed bars. An eccentric pull-out test was used to measure bond strength in specimens. Results indicate conservatism in the ACI Building Code on the matter of minimum bar spacing under some conditions, accompanied by inadequate protection against failure in bond under other circumstances.

Proceedings V. 51

SPECIFICATION FOR THE DESIGN AND CONSTRUCTION OF REINFORCED CONCRETE CHIMNEYS (ACI 505-54) 51-1

COMMITTEE 505 — Sept. 1954, pp. 1-48 (V. 51)

Supersedes 49-26

This specification sets forth recommended loadings, including provision for both wind and earthquake, for the design of reinforced concrete chimneys and recommended methods for determining the stresses in the concrete and reinforcement resulting from these loadings. The method of analysis includes determination of the stresses at horizontal cross sections where flue or other openings occur as well as at sections where the cross section is an annular ring. Charts containing curves to aid in the rapid solution of the specified formulas are included. While the method of analysis applies primarily to chimneys, it can be used for other hollow circular cross sections, with or without openings, where the shell thickness is small in proportion to the diameter.

Formulas are recommended for determining the temperature gradient through the concrete resulting from the difference in temperature of the gases inside the chimney and the surrounding atmosphere, together with methods for determining the stresses in the concrete and reinforcement both vertically and circumferentially due to the temperature gradient through the concrete.

Formulas for combining the stresses due to dead, wind, and earthquake loads with the stresses due to temperature are included in the specification, together with recommended allowable stresses in the concrete and reinforcement for the various stress combinations.

The specification covers the mixing and placing of the concrete by reference to the ACI "Building Code Requirements for Reinforced Concrete (ACI 318)" with supplemental provisions to take care of the special requirements for concrete chimneys.

The specification also includes recommended practice for linings for concrete chimneys, where required for lightning protection, access ladders, and other chimney accessories.

In an appendix many of the equations used are derived and the assumptions on which they are based are given.

RECOMMENDED PRACTICE FOR SELECTING PROPORTIONS FOR CONCRETE (ACI 613-54) 51-2

COMMITTEE 613 — Sept. 1954, pp. 49-64 (V. 51)

Supersedes 44-26 and 50-6

The proportioning of concrete, including mixes containing entrained air, is set forth in this recommended practice. Tables are provided which, along with laboratory tests on physical properties of fine and coarse aggregate, yield information rapidly for obtaining concrete proportions. Three examples are included in the design of air-entrained and non-air-entrained mixes which utilize the tables. Adjustment of aggregate proportions due to moisture present in aggregates is illustrated. Laboratory tests are given in the appendix and include those on physical properties of cement and aggregate. Also included is a simple method of obtaining mix proportions for the small job.

PROPERTIES OF HEAVY CONCRETE MADE WITH BARITE AGGREGATES . . 51-3

L. P. WITTE and J. E. BACKSTROM — Sept. 1954, pp. 65-88 (V. 51)

Reports results of tests performed on barite (barium sulfate) to determine its physical properties and its potential value as an aggregate in conventional and prepacked concrete where high density is desired. The concretes developed were tested under a variety of conditions to determine their physical, chemical, and structural characteristics.

Barite aggregate behaves in concrete similarly to an ordinary crushed aggregate such as limestone or basalt, and no special problems were encountered in selecting and proportioning the constituents of the concretes. Exceptionally high compressive strengths were developed by conventional barite concrete. Prepacked barite concretes did not develop these high strengths. Coefficient of thermal expansion is approximately twice that of concrete containing a good natural aggregate similar to that used in Grand Coulee Dam. Values of specific heat, thermal, conductivity, and diffusivity are approximately one-half those obtained with the natural aggregate concrete. Concretes having densities of as much as 232 lb per cu ft were obtained. Concrete of high density is desirable for shielding in certain areas of atomic plants. Barite might also serve as riprap for bank protection where weight is desirable.

ONE-PIECE REINFORCED PLASTIC FORMS FOR ASSEMBLY LINE PRODUCTION OF THIN-SHELL CONCRETE ROOF SECTIONS 51-4

GEORGE P. DUECY and JOHN L. HUTSELL — Sept. 1954, pp. 89-92 (V. 51)

Description of method of producing thin-shell precast concrete sections by adapting assembly line techniques and securing maximum use of lightweight plastic forms. Covers briefly form design, reinforcing assembly, form assembly, concrete placing and curing, stripping, job applications, and costs. The panels are a U. S. Navy Bureau of Yards and Docks design, 4½ ft wide, 20 ft long, with a 1¼ in. shell thickness, and 8 in. deep side beams. The forms are a one-piece steel-reinforced five-ply laminated glass-fiber form of approximately 160 sq ft.

ADMIXTURES FOR CONCRETE 51-5

COMMITTEE 212 — Oct. 1954, pp. 113-148 (V. 51)

With the aim of providing a perspective of the field of admixtures for the engineer confronted with a need of modifying concrete to meet special requirements of a given job, admixtures are classified into 11 groups. The 11 groups are: (1) accelerators, (2) retarders, (3) air-entraining agents, (4) gas-forming agents, (5) cementitious materials, (6) pozzolans, (7) alkali-aggregate expansion inhibitors, (8) dampproofing and permeability reducing agents, (9) workability agents, (10) grouting agents, and (11) miscellaneous. Discussions are given of the factors which might indicate the usefulness of admixtures of each group, and of the important effects which may ordinarily be expected from the use of material of each group.

(See 41-5 for earlier report)

PRECAST CONCRETE SANDWICH PANELS FOR TILT-UP CONSTRUCTION 51-6

F. THOMAS COLLINS — Oct. 1954, pp. 149-164 (V. 51)

Design and construction details are presented on precast concrete wall panels of sandwich panel design. While most precast concrete sandwich wall panels to date have been factory fabricated in relatively small panels, advantages are cited for casting large sandwich panels for tilt-up construction. Details are given on various types of sandwich panels. Some fundamenta's of design for conventional sandwich walls are given with sample calculations. An example wall is designed for tilt-up construction. Incorporation of prestressing in such a panel is discussed. A cost analysis is also included.

PRODUCTION OF SAND AND GRAVEL 51-7

STANTON WALKER — Oct. 1954, pp. 165-180 (V. 51)

Production of sand and gravel is discussed under three main groupings: (1) development of deposits, (2) transportation to the plant, and (3) processing. Briefly detailed are prospecting and exploration, excavation, and transporting methods. Described in more detail are processes for washing, classifying, removing deleterious impurities, and crushing oversized materials. A list of 32 selected references completes the report.

ULTIMATE STRENGTH IN SHEAR OF SIMPLY-SUPPORTED PRESTRESSED CONCRETE BEAMS WITHOUT WEB REINFORCEMENT 51-8

E. M. ZWOYER and C. P. SIESS — Oct. 1954, pp. 181-200 (V. 51)

Tests were made on 34 simply-supported prestressed concrete beams without web reinforcement. All beams were rectangular in cross section and were reinforced with straight wires bonded throughout their length. Variables included the prestress, the percentage and type of steel, the concrete strength, and the ratio of shear-span to depth of beam. On the basis of the results obtained, an hypothesis of failure was developed which is consistent with the phenomena observed in the tests and which provides the basis for a method of analysis capable of predicting the strength in shear of beams similar to those tested. This method of computing shear strength can be applied also to beams of ordinary reinforced concrete, and comparisons with the results of tests show reasonably good agreement.

MODEL ANALYSIS OF A SKEWED RIGID FRAME BRIDGE AND SLAB... 51-9

D. H. PLETTA and D. FREDERICK — Nov. 1954, pp. 217-232 (V. 51)

Results of an experimental analysis of a small aluminum model of a skewed-slab rigid-frame bridge are presented. A model theory is also checked using reinforced concrete as the model material by testing three sizes of geometrically similar simple beams and a model of a skewed slab with curbs. The slab is a ⅛-scale model similar to a ½-scale model tested previously at the University of Illinois. Results indicate that small reinforced concrete models do behave just as their prototypes up to the ultimate load, and it now seems possible to test models of entire structures rather than just their component parts as has been the practice in the past.

FUNDAMENTAL FACTORS IN THE DRYING SHRINKAGE OF CONCRETE BLOCK 51-10

GEORGE L. KALOUSEK — Nov. 1954, pp. 233-248 (V. 51)

Shrinkage of concrete block dried to stable condition successively at 85, 70, 50, and 25 percent relative humidity was not always related to moisture loss. In one series of tests, block underwent slight expansion for a time while losing moisture at 70 percent relative humidity. Sand and gravel block dried at 25 percent relative humidity showed no expansion during rehumidification at 50 and 70 percent relative humidity although up to 17 percent of the total moisture content was readsorbed.

Measurement of apparent surface areas by water vapor and nitrogen adsorption suggested a clue as to the mechanism by which water caused volume changes in concrete block. The amounts of water vapor adsorbed were approximately twice those required to cover the true internal surface as determined by nitrogen adsorption. The amount of this excess water, designated "interlayer" water, was about 0.7 times as large for autoclaved units as for normally cured units. Since the autoclaved block showed a shrinkage about 0.6 times as large as that manifested by the normally cured ones it appeared that the amount of shrinkage may be proportional to the amount of the "interlayer" water. The volume changes with adsorption and desorption of water, at least at moderate to low humidities, could be caused by the change in size of the unit cell of the structure of the cementitious phase. The manner in which the capillary phenomenon may contribute to volume change is considered. The capillary-tension force is probably operative only at high humidities.

TEST HAMMER PROVIDES NEW METHOD OF EVALUATING HARDENED CONCRETE 51-11

GORDON W. GREENE — Nov. 1954, pp. 249-256 (V. 51)

The Schmidt concrete test hammer provides a convenient method of determining the strength of nearly any concrete mass that has a smooth, flat surface. The test is nondestructive. Results of tests made with the instrument are compared with results of compression and flexure tests. Factors causing variation in results with each test method are discussed briefly, and the accuracy of the test hammer is compared with that of the testing machine.

ULTIMATE LOAD THEORY AND TESTS OF CYLINDRICAL LONG SHELL ROOFS 51-12

G. C. ERNST, R. R. MARLETTE, and G. V. BERG — Nov. 1954, pp. 257-272 (V. 51)

An ultimate load theory for thin-shell roofs, developed independently by A. L. L. Baker and K. W.

Johansen, is presented with modifications as applicable to the design of long, simply supported, cylindrical shells. The basis of analysis is similar to a rupture theory by H. Lundgren. In addition to design equations for long cylindrical shells, results from exploratory tests are presented in confirmation of the theory. The theory and equations are intended to supplement, not supplant, existing elastic theory.

"ACCIDENTAL" AIR IN CONCRETE . . 51-13

M. F. MACNAUGHTON and JOHN B. HERBICH — Nov. 1954, pp. 273-284 (V. 51)

Deals with instances where "accidental" air in concrete was found to be present in amounts far beyond those normally encountered in plain mixtures. Lists a number of such cases which have come to attention in the area in Canada covered by the Laurentian shield. In connection with one specific instance an outline is presented of the investigation of the problem and the measures adopted to control vagrant and final air content in the concrete mixtures on the work within reasonable and normally acceptable limits.

PERMEABILITY OF PORTLAND CEMENT PASTE 51-14

T. C. POWERS, L. E. COPELAND, J. C. HAYES, and H. M. MANN — Nov. 1954, pp. 285-300 (V. 51)

Apparatus and methods for measuring the permeability of portland cement pastes are described. Test results are given showing the effects of curing, cement content, cement composition, and cement fineness. Also, data on some rocks are compared with data on hardened pastes.

SHEAR STRENGTH OF REINFORCED CONCRETE BEAMS. PART 1 — TESTS OF SIMPLE BEAMS 51-15

See also Title No. 51-21, 51-28, and 51-34

K. G. MOODY, I. M. VIEST, R. C. ELSTNER, and E. HOGNESTAD — Dec. 1954, pp. 317-332 (V. 51)

Data are presented on the shear strength of 42 simple beams, 40 without web reinforcement and two with web reinforcement. Tests were carried out in three series with the following variables: (1) percentage of longitudinal and web reinforcement, and method of anchorage, (2) size and percentage of longitudinal reinforcement and strength of concrete; and (3) concrete mixture and method of curing. The size of specimen was different for each of the three series.

The beams were tested with one or two concentrated loads and all failed in shear after one or more diagonal tension cracks formed in the region of maximum shear. The magnitude of the loading causing the initial diagonal tension cracks depended primarily on the cross section and the concrete strength. Most beams were able to sustain greater loads than the cracking loads. Magnitude of failure loads depended on cross section dimensions, amount of longitudinal reinforcement, amount of web reinforcement, strength of concrete, and length of shear span. Failure was by destruction of the compression zone of concrete above the diagonal tension crack and adjacent to a loading block.

Tests results indicated that strength of beams with large *a d* ratios may be governed by the load causing first cracking whereas the strength of shorter beams is governed by the load causing the destruction of the compression zone of concrete. Results also indicate that the load at first cracking may be predicted on the basis of nominal shearing stress and the ultimate load may be predicted on the basis of ultimate moment.

EFFECT OF ALGAE INFESTED WATER ON THE STRENGTH OF CONCRETE 51-16

BENJAMIN C. DOELL — Dec. 1954, pp. 333-344 (V. 51)

The purpose of this study was to establish a relationship between loss in strength of concrete and various concentrations of organic matter contained in algae infested water. Various amounts were added to the mixing water of test batches with the resulting cylinders tested to 28 and 60 days. A close approximation of the allowable concentration of organic matter in a good mixing water was established.

OBSERVATIONS ON THE RESISTANCE OF CONCRETE TO FREEZING AND THAWING 51-17

HUBERT WOODS — Dec. 1954, pp. 345-352 (V. 51)

A survey and analysis of the more important investigations on freezing and thawing of concrete show that significant general conclusions can be drawn. Some of these conclusions are presented in a manner designed to show their reasonableness, but without detailed evidence.

SOME FAILURES OF REINFORCED CONCRETE STORAGE BINS 51-18

LOUIS E. VANDEGRIFT — Dec. 1954, pp. 353-360 (V. 51)

Some failures of reinforced concrete storage bins due to improper reinforcing of the fillets at the interstice bin corners are illustrated. Simple model tests demonstrate the need for steel at these points.

STATIC AND FATIGUE TESTS ON PARTIALLY PRESTRESSED CONCRETE CONSTRUCTIONS 51-19

P. W. ABELES — Dec. 1954, pp. 361-376 (V. 51)

Discusses an investigation of the essential features of partial prestressing. Static and fatigue tests as well as routine acceptance tests are described.

A few of the conclusions drawn are: (1) Cracks should not form in acceptance tests under bending tensile stress of 750 and 800 psi for pretensioned wires or 650 psi for post-tensioned wires. (2) In the former case no cracks should form under fatigue loading corresponding to a bending tensile stress of 650 psi. (3) When cracks have occurred and fatigue loading takes place, up to a bending tensile stress of 650 psi, the cracks disappear on removal of the load and no noticable deformation remains. (5) Several million repetitions of the fatigue load do not affect the subsequent static failure load.

STRUCTURAL APPLICATIONS OF HYPERBOLIC PARABOLOIDICAL SHELLS 51-20

FELIX CANDELA — Jan. 1955, pp. 397-416 (V. 51)

Advantages of hyperbolic paraboloidical surfaces are given. Theoretical considerations and formulas for stress investigations of such structures are reviewed briefly. Some applications of these structural shapes are described.

SHEAR STRENGTH OF REINFORCED CONCRETE BEAMS. PART 2 — TESTS OF RESTRAINED BEAMS WITHOUT WEB REINFORCEMENT . . . 51-21

See also Title No. 51-15, 51-28, and 51-34

K. G. MOODY, I. M. VIEST, R. C. ELSTNER, and E. HOGNESTAD — Jan. 1955, pp. 417-436 (V. 51)

Data are presented on the shear strength of 61 restrained beams without web reinforcement. Tests were carried out in five series with the following variables: (1) concrete strength and percentage of longitudinal reinforcement, (2) beam depth, (3) ratio of shear span to effective depth of beam, (4) cutting off the reinforcement in accordance with the ACI Building Code, and (5) relative magnitude of negative and positive moments.

The beams were tested with one concentrated load at each overhang and one or two concentrated loads in the span. All beams failed in shear after one or more diagonal tension cracks formed in the regions of maximum shear. Up to the formation of diagonal tension cracks, the behavior of all beams was the same as that of beams failing in flexure. Formation of diagonal tension cracks led to a new distribution of internal stresses which prevailed until failure.

Magnitude of the load causing the formation of the initial diagonal tension cracks depended primarily on the dimensions of the cross section and on the

strength of the concrete. Increases of load beyond the cracking load were made possible by redistribution of internal stresses. At failure, the compression zone of concrete was destroyed at the critical section. Magnitude of the ultimate loads depended primarily on the dimensions of the cross section, on the amount of longitudinal reinforcement, on the concrete strength, and on the ratio M/Vd. Ratio of the ultimate load to the cracking load decreased with increasing ratio of shear span to effective depth.

SIMPLIFIED METHOD FOR THE DETERMINATION OF APPARENT SURFACE AREA OF CONCRETE PRODUCTS 51-22

L. F. GLEYSTEEN and G. L. KALOUSEK — Jan. 1955, pp. 437-448 (V. 51)

The hypothesis that the cementitious solid of autoclaved concrete products is crystalline and that of moist-air or atmospheric-steam units is gel-like in form served as the basis for this study. Estimate of degree of crystallinity was based on surface areas computed from BET nitrogen adsorption data. The results contradicted the hypothesis, the autoclaved products manifesting surface areas nearly twice as large as those of normally cured products. Water adsorption data obtained by a simple gravimetric adsorption method developed in this study indicated apparent areas of about equal magnitude for both types of curing, but these computed areas were much larger than those shown by nitrogen adsorption.

DESIGN AND CONSTRUCTION OF A FOLDED PLATE ROOF STRUCTURE 51-23

MILO S. KETCHUM — Jan. 1955, pp. 449-456 (V. 51)

The H. W. Moore Equipment Co. building, a reinforced concrete structure in Denver, Colo., utilized two types of folded plate shells: a discontinuous Z-shaped shell arranged to provide a north light clerestory, and a continuous series of inverted V-shapes. The latter shell was designed to carry two 15-ton cranes on the roof system. The analysis of stresses made use of the latest refinements involving the effect of deflection on the transverse stresses in the slabs.

The roof plates were constructed with both conventional and movable forms, and some structural elements were precast on the ground and raised into place.

RIBLESS CYLINDRICAL SHELLS 51-24

MARIO G. SALVADORI and A. D. ATESHOGLOU — Jan. 1955, pp. 457-460 (V. 51)

Cylindrical shell roofs are usually designed as thin flexureless membranes stiffened by transverse ribs or arches. In many cases, particularly when the spans are relatively small and the shell is shotcreted rather than cast in place, it is economical to extend the shell to the ground and eliminate the ribs. Paper evaluates the maximum bending moments; thrusts; and the vertical reactions due to dead load, live load, temperature variations, and wind in this type of structure.

COMPARISON OF RESULTS OF THREE METHODS FOR DETERMINING YOUNG'S MODULUS OF ELASTICITY OF CONCRETE 51-25

R. E. PHILLEO — Jan. 1955, pp. 461-472 (V. 51)

The elastic response of concrete to static, resonance, and pulse velocity tests is discussed. Because of the wide variations in static testing techniques and the heterogeneity of concrete, the results of Young's modulus calculated from the three methods do not necessarily agree. The pulse velocity method has advantages over the other two in that testing is not confined to regularly-shaped laboratory specimens, and results are free from inelastic effects. The method, however, has severe limitations: it is so affected by the heterogeneity of concrete that calculations of Young's modulus are discouraged, and it is not sensitive to small changes in the paste component of concrete.

AN INTERPRETATION OF SOME PUBLISHED RESEARCHES ON THE ALKALI-AGGREGATE REACTION. PART 1 — THE CHEMICAL REACTIONS AND MECHANISM OF EXPANSION 51-26

See also Title No. 51-40

T. C. POWERS and H. H. STEINOUR — Feb. 1955, pp. 497-516 (V. 51)

Research results are interpreted as having the following indications: The relative reactivity of a given form of silica is determined by the number of interrupted silicon-oxygen-silicon linkages, a matter of specific surface and "holes" due to disorderly atomic arrangements. Caustic attack on reactive silica in the presence of excess lime produces a nonswelling lime-alkali-silica complex if chemical equilibrium is reached. In affected concrete some of this complex is produced, but abnormal swelling is due to the formation of an alkali-silica complex which is not in equilibrium with lime. The persistence of the nonequilibrium product appears to be due to the inability of lime to diffuse into the reactive particle where alkali-silica complex has formed. Expansion of concrete is probably due primarily to the swelling of solid alkali-silica complex, but it may also be due to hydraulic pressure generated by osmosis, or by both mechanisms.

SPECIAL PURPOSE WATERFRONT STRUCTURE OF PRECAST REINFORCED CONCRETE 51-27

WIN E. WILSON — Feb. 1955, pp. 517-524 (V. 51)

Describes the design and construction of a special ramp, built for the U. S. Navy, using a precast concrete system. Basically, it consists of precast reinforced concrete bearing piles set on the apexes of equilateral triangles supporting precast girders which in turn support triangular deck slabs. The tops of the piles were fitted with special anchors and bearing plates to receive the connections at each end of the girders.

SHEAR STRENGTH OF REINFORCED CONCRETE BEAMS. PART 3 — TESTS OF RESTRAINED BEAMS WITH WEB REINFORCEMENT.......51-28

See also Title No. 51-15, 51-21, and 51-34

R. C. ELSTNER, K. G. MOODY, I. M. VIEST, and E. HOGNESTAD — Feb. 1955, pp. 525-540 (V. 51)

Results are presented from tests on 35 restrained beams with web reinforcement. The tests were made in three series: the first comprising 22 rectangular beams and two T-beams was made as the basic series of tests designed to investigate the effects of varying amount and inclination of web reinforcement, the second comprising eight rectangular beams was made to investigate the effect of increasing beam depth, and the third comprising three rectangular beams was made to investigate the effect of increasing the ratio of shear span to effective depth of beam.

Beams were tested with one concentrated load at each overhang and one or two concentrated loads in the span. In all beams several diagonal tension cracks formed in the regions of maximum shear. One beam failed in flexure and the remaining beams failed in shear. The magnitude of the cracking load was found to depend primarily on the dimensions of the cross section and strength of concrete. All beams were able to support substantially greater loads than the cracking loads. The final shear failure occurred by destruction of the compression zone of concrete at the support or load bearing block. The magnitude of the failure load was clearly a function of the amount and type of web reinforcement.

MAGNETITE IRON ORE CONCRETE FOR NUCLEAR SHIELDING 51-29

J. O. HENRIE — Feb. 1955, pp. 541-552 (V. 51)

Discusses crushing and handling of the magnetic iron ore, which was used as the aggregate for a dense shielding concrete, and the physical properties and costs of magnetite ore concrete are compared to those

of other concretes. The mix used had a compressive strength of 4000 psi in 10 days. The methods used in fabricating shielding block are described. Recommendations for producing a low cost, relatively high density shielding concrete are made. The shielding block used (9 x 9 x 18 in. nominal) had a density of 3.7 g per sq cm or 230 lb per cu ft and cost $163.50 per cu yd. The dimensions of the block were quite uniform, having a standard deviation of approximately 0.015 in.

FLAT SLAB SOLVED BY MODEL ANALYSIS 51-30

GERALD BOWEN and R. W. SHAFFER — Feb. 1955, pp. 553-572 (V. 51)

A practical model analysis procedure for determining elastic moments, shears, torsions, and deflections in any plate structure under transverse loads is presented. This method, known as "photo reflective stress analysis" or the "Presan method," is described in some detail. A specific analysis and reinforcing steel design of a continuous square bay flat plate supported by columns of finite diameter is presented and compared to mathematical analysis of the same structure using ACI Building Code moment coefficient (M_o) and standard elastic analysis and design procedures.

FLY ASH — SULFUR MIXTURE FOR CAPPING CONCRETE TEST CYLINDERS 51-31

HUBERT F. McDONELL — Feb. 1955, pp. 573-576 (V. 51)

Various materials used in capping concrete cylinders were investigated to develop, if possible, a mixture that was economical and would produce caps that within 2 hr would not flow or fracture when the specimen was tested. A fly ash-sulfur mixture combined in the proper proportions and melted and used at the recommended temperatures produced caps that met all of the requirements.

DESIGN OF BLAST RESISTANT CONSTRUCTION FOR ATOMIC EXPLOSIONS 51-32

C. S. WHITNEY, B. G. ANDERSON, and E. COHEN — Mar. 1955, pp. 589-684 (V. 51)

Methods and principles used in designing the first full scale blast resistance structures tested at Eniwetok are presented and the test results are cited in support of the procedures outlined. Economic and other practical considerations are discussed. Radiation hazards and methods of dealing with them are described.

Appendices are included which give detailed procedures for computing the blast loading, for designing individual structural elements and single and multistory buildings in both the elastic and plastic range for this loading, for computing ultimate strength of structural elements and frames under rapid loading, and for dealing with some special problems.

VIBRO-CAST CONCRETE PIPE FOR SAN DIEGO PROJECT 51-33

S. J. TURLEY — Mar. 1955, pp. 685-696 (V. 51)

The manufacture and production of large diameter concrete pipe used on the San Diego Aqueduct for transporting water in rough mountainous country are described with emphasis on the control and amount of concrete involved.

Use of overhead cranes for all pipe handling, close control of vibration, use of the largest practical size of aggregate with a lower cement factor, and a reduced amount of entrained air contributed to the production of excellent pipe.

SHEAR STRENGTH OF REINFORCED CONCRETE BEAMS. PART 4 — ANALYTICAL STUDIES. 51-34

See also Title No. 51-15, 51-21, and 51-28

K. G. MOODY and I. M. VIEST — Mar. 1955, pp. 697-732 (V. 51)

Results of tests on 136 simple and restrained rectangular beams, with and without web reinforcement, failing in shear were reported in Parts 1, 2, and 3 and are analyzed in this paper. From the reported tests, it was found that to predict the shear strength of a reinforced concrete beam two analytical expressions are required: (1) for the load at which diagonal tension cracks form, and (2) for the load at which the compression zone of concrete is destroyed. The solution of the first problem, the cracking load equation, was obtained from test data as an empirical expression for the nominal shearing stress corresponding to the maximum shear; the second problem, the ultimate strength equation, was solved by a semirational expression in terms of the ultimate moment at the failure section.

LOOKING AHEAD 51-35

CHARLES H. SCHOLER—Apr. 1955, pp. 733-741 (V. 51)

Retiring ACI President Scholer looks ahead to the Institute's second 50 years. It is emphasized that part of the Institute's service to the concrete field is to reiterate the established principles of better concrete, not only to the new and unfamiliar, but especially to the established and eminent persons in the field.

THEORY OF THE SECONDARY ARCH 51-36

B. F. JAKOBSEN — Apr. 1955, pp. 741-756 (V. 51)

For circular arches having a ratio of thickness to mean radius greater than 0.3, a central angle less than 100 deg, and under normal loads, high tensile stresses are indicated both at the crown and at the abutments by the usual formulas. A method of computation is proposed which assumes that the stress distribution is linear on radial sections and that the part of the arch not subject to compression may be disregarded.

PREFABRICATED FACTORY CONSTRUCTION IN DENMARK 51-37

R. A. LARSEN and VAGN USSING — Apr. 1955, pp. 757-764 (V. 51)

Development in methods of prestressing and prefabrication of concrete has been rapid in Denmark. The design, production, and erection of 400,000 sq ft of factory buildings are described and total erection time and cost are discussed.

STRENGTH VARIATIONS IN READY-MIXED CONCRETE 51-38

A. E. CUMMINGS — Apr. 1955, pp. 765-772 (V. 51)

Presents the results of a statistical analysis of the variations in crushing strength of concrete test cylinders made of commercial ready-mixed concrete delivered to a construction job. The investigation included approximately 1000 cu yd of concrete. Test cylinders were made from every batch delivered to the job for a period of several weeks and the 7-day and 28-day strengths were determined by crushing tests in the laboratory. The test results were then subjected to mathematical analysis by statistical methods to determine the coefficient of variation of the crushing strengths.

BALANCED DESIGN OF PRESTRESSED CONCRETE BEAMS . . .51-39

HENRY J. COWAN — Apr. 1955, pp. 773-784 (V. 51)

Equations are derived for the design of prestressed sections to develop the full value of permissible stresses in concrete both at the top and bottom of the beam during the prestressing operation as well as under the action of superimposed loads. A simple solution is obtained if the maximum permissible stresses are the same during the prestressing operation and under load. The more complicated solution for differential permissible stresses, however, gives greater economy in materials. Two examples are worked out, which demonstrate that balanced design is primarily useful for the heavily loaded beam and the beam with restricted depth.

AN INTERPRETATION OF SOME PUBLISHED RESEARCHES ON THE ALKALI-AGGREGATE REACTION. PART 2 — A HYPOTHESIS CONCERNING SAFE AND UNSAFE REACTIONS WITH REACTIVE SILICA IN CONCRETE 51-40

See also Title No. 51-26

T. C. POWERS and H. H. STEINOUR — Apr. 1955, pp. 785-812 (V. 51)

Enlarging on considerations set down in Part I, the authors develop a hypothesis concerning reactions between reactive silica, calcium hydroxide, and alkali in concrete. The hypothesis is that the reaction proceeds safely or unsafely according to the relative amounts of calcium hydroxide and alkali adsorbed in the outer part of the reacted layer of the opal particle. Published experimental data are analyzed according to the hypothesis with the aid of Kalousek's data on the lime-alkali-silica-water system. Several conclusions are drawn, bearing on safe limits of alkali content and safe silica-alkali ratios.

EFFECT OF CURING ON THE PROPERTIES AFFECTING SHRINKAGE CRACKING OF CONCRETE BLOCK 51-41

J. C. SAEMANN, C. WARREN, and G. W. WASHA — May 1955, pp. 833-852 (V. 51)

This investigation attempted to establish relationships between curing procedures and properties that influence shrinkage cracking of concrete block. Shrinkage cracks are influenced by the strength and stiffness properties of the concrete as well as its tendency to shrink because of moisture and temperature changes. In resisting cracking the tensile strength, notably weak for concrete, and the amount of strain accompanying a given stress must be considered. This latter factor is complicated by the fact that concrete tends to deform continuously at a decreasing rate under constant stress. Thus, the ratio of stress is much lower when concrete sustains a load for a long time.

Tests were made to determine modulus of rupture compressive strength, tensile strength, modulus of elasticity in transverse bending, moisture volume changes, and thermal volume changes. These tests were not intended to provide results that would tell when cracking would occur and when it would not. The objective was to compare the results of tests obtained for block-type concrete made with various aggregates and cured in different ways, and to determine relative immunity to cracking.

PERFORMANCE OF REINFORCED CONCRETE AND CONCRETE MASONRY IN RECENT WESTERN UNITED STATES EARTHQUAKES 51-42

KARL V. STEINBRUGGE and DONALD F. MORAN — May 1955, pp. 853-860 (V. 51)

Recent western United States earthquakes, while not the strongest on record, have given an indication of the effectiveness of modern design methods and construction practices in resisting lateral forces. The examples of damage, although slight in some instances, are keys to weaknesses. The discussion includes cast-in-place reinforced concrete, precast reinforced concrete, and concrete masonry structures. The need for competent field inspection is noted, especially when unusual design or construction features are involved.

BEHAVIOR OF PRESTRESSED CONCRETE COMPOSITE BEAMS 51-43

R. H. EVANS and A. S. PARKER — May 1955, pp. 861-880 (V. 51)

The principal object of the investigation was to determine whether a composite section consisting of in-situ and prestressed concrete acts monolithically with a straight line distribution of strain. Different types of prestressed elements were tested and the quality of bond for varying degrees of roughness of surface was observed. At the same time one set of beams was made specially to investigate the way in which cracks progress across the joint of the two qualities of concretes. Microscopic observations showed that although there is a certain degree of restraint between in-situ and prestressed concrete, the extensibility is unaffected.

In much the same way as shrinkage of concrete in reinforced concrete members produces stresses, differential shrinkage and creep of the two concretes in composite work also have an effect. This was investigated theoretically and the results checked against the observed cracking loads of the beams.

In discussing the significance of the experimental and theoretical results the commercial possibilities of composite construction are considered and various suggestions made with regard to the best type of surface bond, the best relative concrete mixes and times of casting the concrete. The results show that the straight line theory is applicable and stress distributions based on this have been plotted to give examples of good and bad types of combined sections.

BALL TEST FOR FIELD CONTROL OF CONCRETE CONSISTENCY 51-44

JOE W. KELLY and MILOS POLIVKA — May 1955, pp. 881-888 (V. 51)

A simple field test is described for determining consistency of fresh concrete in terms of the penetration of a 6-in. 30-lb ball. Experiences of users are given, and comparisons with slump are made. Considerations in the practical use of the ball are discussed.

STRENGTH OF REINFORCED CONCRETE T-BEAMS UNDER COMBINED DIRECT SHEAR AND TORSION 51-45

EARL I. BROWN, II — May 1955, pp. 889-904 (V. 51)

Tests on longitudinally reinforced concrete sections without web reinforcement are reported. The strength of reinforced concrete T-beams in combined direct shear and torsion are compared to the strength of similar sections in direct shear alone. Theoretical torsion strengths, based on a plastic theory, are in fair agreement with experimental results at first diagonal cracking but are on the safe side.

AIR ENTRAINMENT IN CEMENT AND SILICA PASTES 51-46

G. M. BRUERE — May 1955, pp. 905-920 (V. 51)

The air-entraining capacities of a number of surface-active agents in cement and silica pastes were measured by a standard test procedure. In addition, measurements were made of the foaming properties of surface-active agent solutions with and without electrolyte additions, and of the abilities of surface-active agents to make cement and silica-particles hydrophobic by adsorption so that air bubbles adhere to them. These sets of data were used to demonstrate the conditions governing the formation of stable, air-entrained pastes containing surface-active agents, and the mechanisms by which air bubbles are introduced into and retained in pastes.

ECCENTRIC BENDING IN TWO DIRECTIONS OF RECTANGULAR CONCRETE COLUMNS 51-47

LU-SHIEN HU — May 1955, pp. 921-936 (V. 51)

Four charts are presented for checking the stresses in a rectangular reinforced concrete section subjected to bending in two directions with or without normal compressive force. These charts can be used for sections with symmetrical as well as nonsymmetrical steel arrangement. The only limitation of the use of these charts is the rectangularity of the section.

The assumption that the slope of the neutral axis is the same as that for a homogeneous section is used in preparing the charts. The maximum error due to this assumption is shown to be on the safe side and of negligible magnitude even for the worst cases. Four numerical examples are given to illustrate the use of the charts.

The theory of dimensional analysis was applied to the design of reinforced concrete structural models of small home foundation slabs. Methods of fabricating satisfactory models were developed. Static stiffness measurements were reported on six different designs of the same cost and size. Two full-scale foundations were tested corresponding to a pair of the model designs, and model and full-scale results are compared.

Specifications for concrete together with design and control methods as practiced by the City of Milwaukee for pavement construction in the past 10 years are described. Compression strength tests of 3062 — 6 x 12-in. cylinders are summarized for the period 1949-1953 and air content tests numbering 337 are reported beginning with 1951 when air tests were instituted as a control measure. The cement factor specification is preferred by Milwaukee because of the precise bidding basis afforded.

The hydrothermal reactions at temperatures of 125 to 175 C between $Ca(OH)_2$ and quartz or silicic acid have been studied in detail with regard to the reaction products to form particularly in the range of molar compositions of 0.8 CaO:S_1O_2 to 1.25 CaO:S_1O_2. The solid phases were studied by x-ray, DTA, BET nitrogen adsorption, electron microscopy, and chemical analysis. The products prepared from mixtures made with silicic acid were fibrous in form and ranged in composition from 0.8 to 1.25 C/S. The same or closely related solids were also prepared with quartz. The fibrous $C_4S_5H_5$ transformed to tobermorite $C_4S_5H_5$, a platy crystalline solid. The transformation was rapid in mixes made with quartz but comparatively slow in mixtures made with silicic acid. Although the fibrous and platy phases are similar, the differences between the two, particularly in physical properties, appear to be real. The fibrous phase does not integrate and, on drying, undergoes a marked shrinkage. The platy phase integrated into dimensionally stable solids of superior strengths.

An anaytical method is presented whereby minimum width of horizontal base and its relative position can be found for any shape or loading of a cantilever or counterforted retaining wall. The method is particularly applicable to loaded or unorthodox retaining walls such as in basements of some industrial buildings, ditch bunkers and abutments.

Design, fabrication, and erection of precast and prestressed floor and roof beams and slabs of lightweight expanded shale concrete are described. A discussion of the elastic modulus of expanded shale concrete is based on measured camber at prestressing. Cost data on the beams and slabs and a yard test of one prestressed beam are included.

Basic principles underlying the behavior of statically indeterminate prestressed concrete structures were investigated by testing four continuous beams, each 50 ft long. The cracking and ultimate strengths of these beams were measured and evaluated for static loads as well as for repeated loads up to 5,000,000 cycles. Beam reactions, deflections, and strains were recorded for analysis. The effects of adding nonprestressed mild steel reinforcement were studied.

Proceedings V. 52

Describes, and figures show, use of efficient, simple strike-off slip-forms for placing well-consolidated, accurately-surfaced concrete on slopes too flat to form. Data on concrete mixes used in some examples are tabulated. Some notes are included on equipment for horizontal paving other than for highways.

An interferometer procedure was used to determine the attack on characteristic active and nonreactive aggregates over an extended pH range, in solutions of $NaOH$, $Ca(OH)_2$, and in aqueous extracts of high- and low-alkali cements. Curves are given showing the hygroscopicity of high- and low-alkali cement pastes and powders and the same cements with added reactive and nonreactive aggregates. Curves are given showing expansion of the mortar bars containing various percentages of Pyrex glass of different grain sizes. Microscopic studies of reactive aggregates in high-alkali cements are described, and photographs show instances where the major reaction takes place inside the opal grain rather than at the outside of the particle. This effect is rationalized in terms of the uneven distribution of the migratable ions. An expansion of 300 percent is demonstrated when opal reacts with soda to form a sodium silicate hydrate complex. It is believed that this expansion is the major cause of alkali-aggregate distress in concrete.

Recognizing a need for greater coordination of the duties of architect and structural engineer, the author explains his experience with lift-slab construction, using as special reference the new Rouge Office Building of the Ford Motor Co., one of the largest structures built using the lift-slab technique. Certain structural characteristics such as the rigid column pattern vertically and the advantage of cantilevers are pointed out. The author discusses footing and slab deflection problems, and explains the advantage of the photoreflective system of stress analysis in slab design. How a number of other architectural and mechanical features of a building affected by the lift-slab technique must be considered in the architect's planning is discussed. Concluding the article is a summary of the advantages and disadvantages of lift-slab in modern building and a brief appraisal of the future promise of this new method.

Various theories of creep in concrete are critically reviewed. It is suggested that creep is due to more than one cause, notably to viscous flow with a gradual transfer of load to the aggregate, and to moisture

movement due to evaporation and external force, this movement being of the nature of increased shrinkage as compared with a similar unloaded specimen.

SHELL REINFORCEMENT NOT PARALLEL TO PRINCIPAL STRESSES 52-5

EMILIO ROSENBLUETH — Sept. 1955, pp. 61-72 (V. 52)

Current methods of shell design implicitly assume that concrete can take tension. In intermediate steps those methods strive to satisfy strain relationships. The procedure developed herein consistently assigns no tension to the concrete and only takes into account considerations of equilibrium, not strain relationships. The procedure requires the addition and subtraction of stress tensors, which is greatly simplified through the use of Mohr's diagram. It is applicable only to states of pure axial or "membrane" stresses.

HEAVY STEEL-AGGREGATE CONCRETE 52-6

E. I. FIESENHEISER and B. A. WASIL — Sept. 1955, pp. 73-82 (V. 52)

An experimental study of various mix proportions for heavy concrete is described and a proportioning procedure for concrete of given strength and density is explained. The primary object of the investigation was to determine a procedure for the improved proportioning of mixes using steel punchings as coarse aggregate with steel shot of varying size as fine aggregate. First, the individual ingredients were investigated, then, the optimum mixture. Various heavy concrete mixes were made and strength tested at 7, 14, and 21 days.

Tests results are interesting in that they indicate a possible conclusion that the strength of this concrete is proportional to its density, the water-cement ratio being only one of the factors involved in determining the density. This suggests the generalization that, in the plastic range, the strength of any concrete of given ingredients is proportional to its density.

WATERSTOPS IN ARTICULATED CONCRETE CONSTRUCTION 52-7

E. A. ALLEN and E. C. HIGGINSON — Sept. 1955, pp. 83-92 (V. 52)

The problem of making watertight joints in thin-slab concrete structures is treated.

Rubber waterstops commonly used by the Bureau of Reclamation are discussed and illustrated. Properties of the materials, fabrication and installation methods, and laboratory tests are described.

IMPULSE TESTING OF CONCRETE BEAMS 52-8

F. T. MAVIS and F. A. RICHARDS — Sept. 1955, pp. 93-102 (V. 52)

The purpose of this study was to find out whether reinforced concrete beams that are identical except for grade of reinforcement behave alike or differently under identical impulses; and if they behave differently, how much — and why?

Structural-grade bars, and hard-grade bars that had been rolled with identical deformations from a billet of rail steel, were obtained from the same manufacturer. Beams were cast in gang molds with structural-grade and hard-grade bars alternating in adjacent beams. After the preliminary tests, concrete was supplied by truck mixer in large enough quantities so there should be no question about uniformity of concrete in any one batch.

A new testing machine was designed and built to apply identical impulses to two beams in any given test, and instruments and methods were devised to record what happened at any instant during a test. Things that occurred simultaneously were recorded photographically at a rate of 64 exposures a second; and charts were synchronized to show load-deflection-time data with comparable precision.

PROPOSED RECOMMENDED PRACTICE FOR WINTER CONCRETING........ 52-9

COMMITTEE 604 — Oct. 1955, pp. 113-130 (V. 52)

For synopsis see Title No. 52-60

SOME FACTORS WHICH INFLUENCE THE STRENGTH OF BOLT ANCHORS IN CONCRETE 52-10

ROBERT F. ADAMS — Oct. 1955, pp. 131-138 (V. 52)

Many types of anchoring devices are used to anchor conduit, machinery, fixtures, etc., to concrete. Paper describes pull-out tests made with the type known as multiple expansion unit bolt anchors. Best results are attained when the bolt anchors are set in a well-cleaned hole of the proper size and depth. The hole should be drilled with a drill which leaves a rough surface. The depth of the holes should be at least four times their diameter, and they should be placed at least two or three times their depth away from an edge or corner of the concrete if possible. Two anchor units are sufficient for bolt anchors using bolts less than ¾ in. in size, and three units should be used for those ¾ in. or larger. If the anchorage is to take shearing loads, the annular space around the bolt above the anchor units should be filled with a rigid material to support the bolt when a shearing load is applied.

TESTS OF ANCHORS FOR MASS-CONCRETE FORMS 52-11

THOMAS B. KENNEDY and WALTER O. CRAWLEY — Oct. 1955, pp. 139-146 (V. 52)

The tests covered in this paper were intended to determine the holding strength of several designs of anchors for securing cantilever forms to mass concrete surfaces. The investigation consisted of the fabrication of four blocks of low-strength, 6-in. aggregate concrete in which a total of 48 anchors were embedded and tested at ages ranging from 24 to 72 hr. The results indicate that, under the test conditions used, adequate holding strength was developed in practically every case by the time the concrete was 3 days old.

LIVE LOAD AND TEMPERATURE MOMENTS IN SHELLS OF ROTATION BUILT INTO CYLINDERS 52-12

MARIO G. SALVADORI — Oct. 1955, pp. 149-158 (V. 52)

Tabular data are given for the maximum bending moments due to vertical loads and temperature variations in shells of revolution of a large variety of shapes. When shells are elastically built-in into cylinders of the same radius it is shown that the maximum values of the bending moments in the shell and in the cylinder are functions of the ratio of thickness of shell to thickness of cylinder, and can be taken directly from the tabular data without computations.

LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE. CHAPTER 9 — CORRELATION OF THE RESULTS OF LABORATORY TESTS WITH FIELD PERFORMANCE UNDER NATURAL FREEZING AND THAWING CONDITIONS..... 52-13

F. H. JACKSON — Oct. 1955, pp. 159-194 (V. 52)

Summarizes and evaluates the results of laboratory tests spanning 14 years of the Long-Time Study cements and concretes containing them and field tests up to 12 years of concretes containing the same cements. Many of the field installations, although subject to severe exposure, have not weathered sufficiently to allow comparisons. Of the three permitting appraisal the only positive conclusion that can be drawn now is the superior performance of air-entraining cements.

Laboratory freezing and thawing tests of concrete correlate well with field performance in showing the markedly improved durability of air-entrained concretes. Tests at two laboratories and at two of the field installations give some indications, clouded by many inconsistencies, that Type IV cement concretes are somewhat more frost resistant than concretes made of other types of cement. However, this trend is not indicated by other investigations which show quite conclusively that damage by freezing and thawing is a physical matter and is not influenced by the chemical composition of the cement. An over-all appraisal of the results of the Long-Time Study tests to

date indicates that, of the many physical tests made of the LTS cements, only the test for air content is of any value in indicating relative resistance to freezing and thawing.

(See also 44-21, 44-26, 44-33, 44-38, 46-17, 47-51, 49-42, 54-21, and 54-59)

MOVABLE FALSEWORK SPEEDS ARCH RIB CONSTRUCTION 52-14

H. R. LENDECKE, C. H. KNIGHT, JR., and P. G. GRIFFIN — Oct. 1955, pp. 195-200 (V. 52)

Outstanding among the many interesting elements of work on the Colorado Freeway arch bridge over the Arroyo Seco in Pasadena, Calif., was the design and construction of movable steel centering for the arch ribs. The 1364-ft bridge consists of three spans of twin arch ribs plus box girder approach spans. The movable falsework and the erection and movement of it is described in detail.

LAPPED SPLICES IN REINFORCED CONCRETE BEAMS 52-15

JAMES CHINN, PHIL M. FERGUSON, and J. NEILS THOMPSON — Oct. 1955, pp. 201-214 (V. 52)

Tests on spliced reinforcement were performed under conditions where longitudinal splitting was not prevented to study the effect of such splitting on bond capacity. Splices were selected as representative of tension lap splices that might occur in joining precast beams in negative moment regions.

Failures were mostly of two kinds, horizontal splitting extending through the beams at the level of the bars and vertical longitudinal cracks through the bottom cover over the bars. Study included effect of the following: beam width, cover over steel, length of splice, space between splice bars, bar size, stirrups in splice zone, number of splices in a beam, splice position (top or bottom), and various cylinder strengths.

It was found that: increased beam width increased splice strength; increased cover increased splice strength in shorter splices; unit bond stress decreased with increasing splice length, but not as rapidly as surface area increased; splice position had little effect on strength; bar size had an effect on bond strength even when cover, splice length, and beam width were constant in terms of bar diameters; stirrups increased splice strength; little difference in strength occurred between contact and spaced splices; and if bond stress is not limited to 175 psi (as against allowable 350 psi) for $f_c' = 4500$ psi and #6 bottom bars, a safety factor of 2.5 will not always be obtained.

THEORETICAL BASIS OF PRESSURE GROUT PENETRATION 52-16

BRUCE E. CLARK — Oct. 1955, pp. 215-224 (V. 52)

The basic properties of grout which determine its suitability for penetration and filling of openings are its flow characteristics, mobility retention, bleeding, particle sizes; and quality after set. These qualities are discussed, particularly flow characteristics, which for grout includes the properties of plasticity and thixotropy. Suggestions are given for evaluating the suitability of grout for various field uses based on laboratory tests of these properties.

EVALUATION OF COMPRESSION TEST RESULTS OF FIELD CONCRETE.....52-17

COMMITTEE 214 — Nov. 1955, pp. 241-258 (V. 52)

Statistical methods provide valuable tools for assessing results of strength tests, and such information is also of value in refining design criteria and specifications. The report discusses briefly the numerous variations that occur in the strength of concrete and presents statistical methods which are useful in interpreting these variations. Criteria are offered that can be used to establish specifications and maintain required uniformity.

EROSION RESISTANCE OF CONCRETE IN HYDRAULIC STRUCTURES.......52-18

COMMITTEE 210 — Nov. 1955, pp. 259-272 (V. 52)

Attention is given mainly to the physical erosion of concrete in hydraulic structures resulting from particles carried by flowing water and from pitting resulting from cavities forming and collapsing in water flowing at high velocities. Disintegration of concrete by chemical attack as may occur in hydraulic structures is also discussed.

Materials, mix proportions, and construction procedures which will make concrete more resistant to erosion are presented. Means of improving concrete resistance to chemical disintegration are also discussed.

PROPERTIES AND USES OF INITIALLY RETARDED CONCRETE 52-19

LEWIS H. TUTHILL and WILLIAM A. CORDON — Nov. 1955, pp. 273-286 (V. 52)

Loss of slump and workability and higher water requirement, particularly in warm weather, often impair quality of concrete. Investigation of corrective agents included development of a penetration resistance test to measure rate and progress of hardening, which is described. The effect of various factors such as temperature, character and amount of cement, and type and amount of retarding agent on rate of hardening, early strength, water requirement, and durability are reported.

KEMANO PENSTOCK TUNNEL LINER BACKFILLED WITH PREPACKED CONCRETE 52-20

R. E. DAVIS, JR., G. D. JOHNSON, and G. E. WENDELL — Nov. 1955, pp. 287-308 (V. 52)

The 11-ft diameter underground penstock tunnel which, under a 2600-ft static head, supplies water to the Aluminum Co. of Canada power plant at Kemano, British Columbia, was backfilled with prepacked concrete. Unique with respect to magnitude of operating head and size of penstock, the steel liner was designed on the assumption that a large percentage of the total water load would be transmitted through the backfill to the rock surrounding the tunnel. To achieve this condition it was necessary that the backfill be substantially free of voids and that the temperature rise produced by hydrating cement be low.

Coarse aggregate for the backfill was placed down steeply inclined sections for distances up to 2000 ft by a tremie pipe so as to fill the space between liner and rock. In horizontal sections, coarse aggregate was pneumatically transported and placed for distances up to 600 ft by a "rock blower" and conveyor pipe. The voids of the coarse aggregate backfill were intruded with heavily sanded grout which was pumped horizontally for distances up to 3000 ft and upward nearly 1500 ft. By such grouting, prepacked concrete containing about 4 sacks of cement per cu yd was produced at a maximum rate of about 600 cu yd per day.

After the prepacked concrete had hardened, 1-in diameter cores were taken at many of the liner grout holes. These cores indicated that the backfill was free of voids of significant size. The only holes which took any measurable quantity of neat grout under high pressure were those where the surrounding rock structure was water-bearing or badly fractured. Physical tests on cylinders and cores indicated that ultimate compressive strength of the prepacked concrete was generally in excess of 5000 psi and that, unlike conventional concrete, it behaved as an elastic material even at early ages.

Inspections by tapping with a hammer after the backfill had cooled and hardened have indicated that there was complete contact between liner and backfill. Penstock pressure tests made at two stations where the liner was 1 15/16 in. thick, under a maximum pressure of 1000 psi maintained for 8 hr showed that the backfill was carrying 76 percent and the steel liner 24 percent of the water load. As clear evidence that there were no shallow voids between liner and backfill, such as might be produced along the invert by bleeding, as loading took place the stress in the liner was directly proportional to pressure within the penstock.

EFFECT OF ATMOSPHERIC CONDITIONS DURING BLEEDING PERIOD AND TIME OF FINISHING ON THE SCALE RESISTANCE OF CONCRETE 52-21

PAUL KLIEGER — Nov. 1955, pp. 309-326 (V. 52)

Laboratory tests reported were intended to reveal whether or not changes in bleeding brought about by variations in atmospheric conditions or by varying the time of mechanical manipulation, influenced the resistance of concrete to surface scaling. Specimens of both non-air-entrained and air-entrained concretes were subjected, during the bleeding period, to variations in wind velocity and temperature and given final finishes at different times during bleeding. After preliminary curing, the specimens were subjected to the scaling test.

Test results indicate that the scale resistance of air-entrained concretes was not influenced by surface exposure, temperature, or time of final finishing, despite changes in bleeding similar to those for non-air-entrained concretes. No scaling developed on any of the air-entrained concretes up to 250 cycles of test.

Both the rate and amount of bleeding and resistance to surface scaling of the non-air-entrained concretes increased with an increase in the velocity of air over the surface. There was no consistent change in rate and amount of bleeding or resistance to scaling with change of temperature (50 to 90 F). There appeared to be a trend toward an increase in resistance with increase in temperature.

Non-air-entrained concrete surfaces struck off immediately after casting, with no further manipulations during or after the bleeding period, showed greater resistance to surface scaling than those given a second and final finish. Since immediate finishing is presently impractical from the standpoint of obtaining a pavement surface of proper riding quality, it appears desirable to delay final finish as long as possible.

DESIGN OF PRESTRESSED CONCRETE MULTIBEAM BRIDGES WITH DIAPHRAGMS AND STIFFENED EXTERIOR BEAMS..52-22

ANDREW GALLIA — Nov. 1955, pp. 327-340 (V. 52)

The method of design given shows that economy can be achieved in prestressed concrete bridges with two stiffened exterior beams and several interior beams supporting a floor slab and interconnected by transverse diaphragms. The exterior beams are stiffened by using the sidewalks as structural members and can easily be constructed as composite beams with a cast-in-place topping.

MIXING WATER CONTROL BY USE OF A MOISTURE METER 52-23

C. B. VAN ALSTINE — Nov. 1955, pp. 341-348 (V. 52)

Conditions at Reservoir No. 22 Dam created severe fluctuations of free moisture in sand and pea gravel. Use of a moisture meter as a basis for adjustments in water is described. Charts show the effectiveness of the device, in conjunction with other control measures, as an aid to producing quality concrete.

ULTIMATE THEORY IN FLEXURE BY EXPONENTIAL FUNCTION 52-24

G. M. SMITH and L. E. YOUNG — Nov. 1955, pp. 349-360 (V. 52)

Describes an approach to ultimate failure of reinforced concrete beams based on an exponential function describing the stress-strain curve in flexure. The exponential function and the generally proposed stress block as described by three parameters are compared. The values generally suggested for these parameters show a remarkable relationship to the exponent used to describe the stress block in flexure.

Expressions for compressive and tensile failure are derived for predicting the ultimate moment of rectangular reinforced concrete beams. The expressions are developed using an exponential function to describe the stress block and an equivalent moment of inertia of the concrete and steel. A comparison of actual ultimate moments with the theoretical moments shows good agreement.

Certain assumptions are made as to the stress-strain relationships in flexure which need further experimental verification.

SIMPLE MOMENTS AND MOMENT DESIGN 52-25

S. E. HUEY — Nov. 1955, pp. 361-374 (V. 52)

Starting with the moment for a simply supported single span, a simple and direct method of moment design for prismatic beams and frames is outlined. The method is exact but lends itself to quick and close approximations for preliminary design.

PROPOSED REVISION OF BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-51) 52-26

COMMITTEE 318 — Dec. 1955, pp. 401-446 (V. 52)

For synopsis see Title No. 52-57

EFFECT OF CARBON DIOXIDE ON FRESH CONCRETE 52-27

J. A. KAUER and R. L. FREEMAN — Dec. 1955, pp. 447-454 (V. 52)

Fresh concrete specimens were subjected to carbon dioxide immediately after molding. These specimens were then cured in various humidities and temperatures in CO_2 atmospheres ranging from 4.5 to 18 percent for 24 to 96 hr. Tests were then made on hardness of surface, depth of carbonation, amount of carbonation on surface as compared with unexposed specimen, and compressive strengths. These tests indicated that fresh concrete exposed to CO_2 resulting from the use of salamanders or other heating devices which exhaust the flue gases directly into the room, have soft surfaces of various depths depending on the concentration of CO_2, the temperature at which concrete is cured, and the humidities under which it is cured.

The authors found that chemically produced hardeners have no appreciable effect on the surface. Grinding the surface is the only way to restore or salvage the concrete.

CONCRETE STRESS DISTRIBUTION IN ULTIMATE STRENGTH DESIGN.....52-28

EIVIND HOGNESTAD, N. W. HANSON, and DOUGLAS McHENRY — Dec. 1955, pp. 455-480 (V. 52)

Test data are presented which demonstrate the reality and validity of the fundamental plasticity concepts involved in ultimate strength design theories such as those presented by Whitney, Jensen, and others.

A review of earlier experimental investigations regarding the stress distribution in the compression zone of structural concrete flexural members revealed that, though many test methods have been tried, very limited direct test data are available. On the other hand, considerable information has been derived indirectly from strength and behavior observed in tests of reinforced beams and columns.

An eccentrically loaded specimen and a test method were developed which permit the flexural stress distribution to be measured. Complete information regarding the flexural stress distribution, including stress-strain graphs with a descending curve beyond the maximum stress, is reported for w/c ratios of 1.0, 0.67, 0.50, 0.40, and 0.33 at test ages of 7, 14, 28, and 90 days.

DESIGN OF CYLINDRICAL SHELLS WITH EDGE BEAM 52-29

L. FISCHER — Dec. 1955, pp. 481-488 (V. 52)

This paper uses the tables and methods of solution described in ASCE Manual of Engineering Practice No. 31 to investigate the effects of an edge beam on the stresses in a single simply supported, cylindrical shell. It concerns a solution heretofore not adequately presented in engineering literature, since it considers the vertical, horizontal, and torsional stiffness of the edge beam.

Four kinds of line loads are introduced and their value obtained by equating four kinds of displacements in the shell and the edge beam. The displacements of the shell are calculated by means of the tables presented in the manual. Expressions for dis-

placements of the edge beam are developed. A numerical example is given and its results are compared with those obtained in the manual.

ULTIMATE STRENGTH DESIGN.....52-30

ACI-ASCE COMMITTEE 327 — Jan. 1956, pp. 504-524 (V. 52)

Presents recommendations and aids for the design of sections by the ultimate strength design method. For usual types of buildings the moments, shears, and thrusts determined by coefficients recommended in the ACI Building Code are utilized in the design formulas recommended by the committee. Similarly, indeterminate structures must first be analyzed by the theory of elastic displacements. Provisions are included for bending moments in compression members, shortening of arches, and deflections. A specific degree of control is recommended for concrete used in structures designed by this method.

DESIGN AND CONSTRUCTION OF HEAVY-DUTY AIRFIELD PAVEMENTS AT EDWARDS AIR FORCE BASE.......52-31

ROBERT J. SHULTZ and ROBERT B. FATHERSON — Jan. 1956, pp. 525-536 (V. 52)

Flight testing and proving modern military aircraft at Edwards Air Force Base required a runway 300 ft wide and 15,000 ft long. The airfield will require ultimately the construction of approximately 2,000,000 sq yd of heavy-duty pavement.

The runway pavement was designed for a 500,000-lb airplane, the load to be carried by four sets of dual wheels. Minor service taxiways were designed for a 100,000-lb gear load and hangar floors for an 80,000-lb gear load. Additional criteria required the 500-ft end sections of the runway be constructed with heat-resistant concrete and that the pavement have an extremely uniform and true finished surface.

Slabs 17 and 19 in. thick constructed to uniform longitudinal grades and extremely flat transverse slopes represent the major design features. Design and construction of the runway is described.

PROPORTIONING OF MIXES FOR STEEL COARSE AGGREGATE AND LIMONITE AND MAGNETITE MATRIX HEAVY CONCRETES....................52-32

DAVID L. NARVER, JR. — Jan. 1956, pp. 537-548 (V. 52)

Discusses structural concrete of heavy weight, utilizing limonite and magnetite ones as fine aggregate and graded steel scrap as coarse aggregate. Criteria are presented for proportioning a concrete mix for specific unit weight as well as a specific compressive strength. Employing various combinations of conventional coarse aggregate and steel aggregate and either conventional, limonite, or magnetite fine aggregate, concrete can be produced with a density from 140 to 330 lb per cu ft. Compressive strength of 3000 psi is reported to be obtainable without difficulty.

PLASTIC FLOW (CREEP) OF REINFORCED CONCRETE CONTINUOUS BEAMS..52-33

G. W. WASHA and P. G. FLUCK — Jan. 1956, pp 549-562 (V. 52)

Previous investigations have provided information about plastic flow behavior of single-span reinforced concrete beams, and have shown the beneficial effect of compressive reinforcement in reducing plastic flow. This paper presents the results of 2½ years of loading of two-span beams resting on three level supports. Eighteen beams were tested, representing three different conditions of reinforcement in each of three beam sizes. Inclusion of arbitrary amounts of compressive steel in positive moment regions of two-span continuous beams is effective in reducing plastic flow deflection. Specifically, inclusion of compressive steel equal in amount to the tensile steel reduced plastic flow deflection by about one-third. Plastic flow in positive moment regions of each beam was accompanied by an increase in the midlength reaction and a corresponding increase in midlength bending moment.

RATTLER LOSSES CORRELATED WITH COMPRESSIVE STRENGTH OF CONCRETE 52-34

E. A. JUMPER, J. D. HERBERT, and C. W. BEARDSLEY — Jan. 1956, pp. 563-572 (V. 52)

A series of tests were made to determine how concrete strength is affected by the property of the coarse aggregate measured by the Los Angeles abrasion test. Aggregates showing rattler losses from 42 to 58 percent were compared. Test results are presented correlating resistance of aggregate to abrasion with compressive strength of concrete. Estimates are given of the additional cement required to offset strength impairment caused by the use of aggregates having low abrasion resistance.

DAMAGE DUE TO FREEZING OF FRESH CONCRETE 52-35

C. J. BERNHARDT — Jan. 1956, pp. 573-580 (V. 52)

When fresh concrete is exposed to sufficiently low temperature, the free water in the concrete is cooled below ~~its~~ freezing point and transforms into ice. This is followed by an expansion which under normal circumstances is about 9 percent. Some tests were made at the Concrete Research Laboratory of the Norwegian Institute of Technology to study to what extent the quality of concrete is influenced by such freezing. The results agree with those reported by Donald McNeese, Title No. 49-21.

EFFECT OF AGGREGATE ON SHRINKAGE OF CONCRETE AND A HYPOTHESIS CONCERNING SHRINKAGE 52-36

GERALD PICKETT — Jan. 1956, pp. 581-590 (V. 52)

A theoretical formula is derived for effect of aggregate on shrinkage of concrete during drying. Experiments designed to test the validity of the formula are reported.

In addition to indicating the validity of the formula, the data give the following indications: (1) First shrinkage is greater than any subsequent expansion or shrinkage resulting from moisture change. (2) At a given aggregate content the shrinkage is approximately proportional to water-cement ratio. (3) After first shrinkage, subsequent volume changes are approximately independent of water-cement ratio. (4) When shrinkages of specimens of the higher water-cement ratio are plotted against the square root of period of drying, the shapes of the curves for second shrinkage are appreciably different from those for first shrinkage in that they have considerable curvature near the origin. An explanation of these effects is given.

ULTIMATE FLEXURAL STRENGTH OF PRESTRESSED AND CONVENTIONALLY REINFORCED CONCRETE BEAMS...52-37

JACK R. JANNEY, EIVIND HOGNESTAD, and DOUGLAS McHENRY — Feb. 1956, pp. 601-620 (V. 52)

Based on experimental and analytical studies of flexural behavior and ultimate strength of beams, the relative performances of various types of prestressed and conventional reinforcement are compared.

Test results of 19 rectangular beams are given, involving (1) three pretensioned, (2) three post-tensioned grouted, (3) five post-tensioned unbonded, (4) three post-tensioned unbonded with deformed bars added, and (5) with conventional deformed bar reinforcement. For three reinforcement percentages, the characteristics of these five types of reinforcement are compared in terms of moment-deflection relationships, deflection recovery, and ultimate strength of beams failing in flexure.

An ultimate strength analysis permitted prediction of measured ultimate moments for all beams with satisfactory accuracy.

TESTING OF BATCHING CONTROLS AND RECORDERS FOR CONCRETE PLANTS 52-38

WOODROW L. BURGESS and CECIL H. WILLETTS — Feb. 1956, pp. 621-632 (V. 52)

Commercially available concrete batching and recording equipment were tested to obtain performance data. Six mixtures were employed using pea gravel (100 percent passing ⅜-in. sieve) to simulate the materials normally contained in concrete mixtures. A minimum of 500 batches was used to evaluate the weighing and recording equipment. One material or group of materials was selected from every fifth batch to be weighed to check the accuracy of the weighing equipment. These tests form a part of the Corps of Engineers Civil Works Investigations Program.

POROSITY OF HARDENED PORTLAND CEMENT PASTES 52-39

L. E. COPELAND and J. C. HAYES — Feb. 1956, pp. 633-640 (V. 52)

Continued study of the properties of hardened portland cement pastes has provided information which makes it possible to estimate porosity of pastes more precisely than is possible by using the original equations of Powers and Brownyard. The total pore volume of hardened pastes is 0.99 w_o. Capillary pore volume is the difference between total pore volume and pore volume characteristic of the gel in hardened pastes.

The pore volume of the gel is assumed to be the lowest pore volume that has been observed in hardened pastes. The paste with the lowest pore volume was made with $w_o/c = 0.235$ and cured for 11 years. The gel porosity calculated for this paste is 0.26. The average number of layers of water molecules on the surface of this saturated gel is 2.38.

LARGE PRESTRESSED CONCRETE ELEVATED TANK FOR DALLAS, TEXAS. 52-40

J. J. CLOSNER and T. CARMEL — Feb. 1956, pp. 641-648 (V. 52)

Describes briefly the design considerations for an elevated prestressed concrete water storage tank. Discusses in greater detail the use of slip-forms in constructing the 83-ft substructure and the concreting of the tank floor, walls, and dome roof and the prestressing of the walls and the dome ring. Rubber joint seals at top and bottom of the walls insured water tightness and prevented transfer of undesirable stresses from the walls to other parts of the structure.

USE OF LARGE TENDONS IN PRE-TENSIONED CONCRETE 52-41

NIELS THORSEN — Feb. 1956, pp. 649-660 (V. 52)

The use of a few large tendons in pretensioned concrete construction, instead of many small ones, cuts field costs and simplifies design. This is especially true for heavy members.

Physical properties of tendons are tabulated for average plant-produced steels based on stress-relieved and as-drawn material. Precautions and tests for evaluating tendons are discussed.

It is shown that the bond in the end zones of a pretensioned member differs from the bond in the interior zones. Both types of bond can be determined by a curve indicating the maximum tension which can be absorbed in a tendon, without slip, at various distances from the end of a member. Methods of determining such curves or part thereof are explained.

When using large tendons, secondary stresses in end zones of pretensioned members become important and may cause cracking if special care is not taken in the design. The use of a few general rules to prevent such cracks are indicated.

A few examples of practical applications of large tendons are described. Some future possibilities are discussed such as the use of bond breaking devices in end zones of pretensioned members and curved tendons.

EFFECT OF AGE OF CONCRETE ON BOND RESISTANCE 52-42

K. R. PEATTIE and J. A. POPE — Feb. 1956, pp. 661-672 (V. 52)

A series of tests was made of the effect of age on the factors controlling bond resistance in the adhesive and frictional stages. Test specimens of the pull-out type utilizing machined polished bars were employed together with some specimens in which the bond resistance was broken down by the application of a torque to the steel.

It was found that bond resistance grows rapidly and at a much greater rate than the compressive strength of concrete. It is suggested that bond resistance is dependent only to a minor degree on the strength of the concrete.

PROPERTIES OF PORTLAND CEMENT PASTES CURED AT ELEVATED TEMPERATURES AND PRESSURES. . . .52-43

N. C. LUDWIG and S. A. PENCE — Feb. 1956, pp. 673-688 (V. 52)

The effects of curing at elevated temperatures and pressures on several physical properties of hardened neat cement pastes are given. Two cements were studied and data are given for heat of hydration, nonevaporable water content, surface available to water vapor, permeability to water, and compressive strength of pastes cured at 80 to 400 F at pressures from atmospheric to 7500 psi, and at ages from 12 hr to 7 days.

Results show that changes in compressive strength of hardened cement paste follow the changes in internal surface area. A decrease in strength occurs at high curing temperatures which may be explained by an increase in the particle size of the hydration products.

The nonevaporable water content decreased slightly at temperatures in excess of 220 F. This is in agreement with recent composition studies reporting hydration products having lower water content at high temperatures.

The change in the amount of water required to form a complete unimolecular layer over the surface of cement particles (V_m) was found to be proportional to the change of curing temperature between 220 and 320 F. This suggests that the cement particles increase in size at a rate which is nearly directly proportional to the increase in curing temperature in the range where rapid strength retrogression occurs.

Heat of hydration tests show that hydration is nearly complete in pastes cured 7 days at 320 and 400 F, and it is indicated that the total heat of reaction of a neat cement paste cured at high temperatures (steam-curing range) may be less than that of the same cement cured at atmospheric temperatures.

The water permeability of hardened cement pastes was found to be quite low at curing temperatures up to about 160 F. Above this temperature, permeability increased rapidly at strength and internal surface decreased.

Curing pressures up to 1000 psi at a temperature of 200 F cause slight increases in heat of hydration, internal surface, and strength at early ages. Pressure in excess of 1000 psi at any age had no great effect. It appears, therefore, that pressures up to 1000 psi increase the early rate of reaction.

PROPERTIES OF HIGH-DENSITY CONCRETE MADE WITH IRON AGGREGATE. . . .52-44

HAROLD S. DAVIS, FREDERICK L. BROWNE, and HARRY C. WITTER — Mar. 1956, pp. 705-726 (V. 52)

Data are presented on the physical properties of several types of mortar and concrete made with iron-bearing aggregate for use in radiation shields. Heavy aggregates used in this investigation included steel punchings, fine steel shot, ferrophosphorus, magnetite, and limonite.

Concrete made with natural heavy aggregates had densities of from 185 to 225 lb per cu ft. One type of concrete made with steel punchings and limonite weighed 273 lb per cu ft. Both the prepacked method and conventional methods were used for fabricating concrete specimens. The results of tests performed on several types of heavy mortars made with fine sand are also reported. Data obtained at elevated temperatures

are presented, as well as data obtained from standard tests on aggregate, concrete and mortar.

The data and experience obtained during this investigation demonstrate that concrete suitable for radiation shields can be made with iron-bearing aggregates by either the prepacked or conventional methods of construction.

SUSTAINED LOAD STRENGTH OF ECCENTRICALLY LOADED SHORT REINFORCED CONCRETE COLUMNS . 52-45

I. M. VIEST, R. C. ELSTNER, and E. HOGNESTAD — Mar. 1956, pp. 727-756 (V. 52)

The principal object of this experimental investigation was to determine which portion of the ultimate strength under fast (short-time) loading can be sustained indefinitely by an eccentrically loaded reinforced concrete column. Forty-five column tests are reported: 13 tests wese made with fast loading, 12 with slow loading, and 19 with sustained loading. In addition to the type of loading, concrete strength and eccentricity of load were the major variables studied.

The test findings indicate that the ultimate strength under sustained loading is only about 10 percent below that for fast loading. It seems satisfactory, therefore, to base safety in ultimate strength design on the ultimate strength equations for fast static loading which equations are substantiated by numerous previous tests.

TWO PRESTRESSED CONCRETE BRIDGES WITH HOLLOW GIRDERS OF PRECAST VACUUM-TREATED ELEMENTS 52-46

R. MORANDI and F. PICCININI — Mar. 1956, pp. 757-766 (V. 52)

Main girders, composed of precast vacuum concrete elements, for two bridges in Sicily were prestressed with a new patented system. The bridges, designed for heavy traffic, are remarkable for their light and slender construction, which presents a record for the minimum amount of concrete needed.

LOAD CAPACITY OF CONCRETE BEAMS IN BENDING 52-47

AKE HOLMBERG — Mar. 1956, pp. 767-770 (V. 52)

Reviews past research by various investigators and arrives at two equations by which the load capacity of a concrete beam in bending may be estimated.

EFFECT OF CHEMICAL NATURE OF AGGREGATE ON STRENGTH OF STEAM-CURED PORTLAND CEMENT MORTARS 52-48

T. THORVALDSON — Mar. 1956, pp. 771-780 (V. 52)

Portland cement mortars made with various minerals as aggregates (1 part cement to 4 parts aggregate by volume) were cured in saturated steam at 150 C. The tensile strengths were compared with those attained by curing at 21 C. Among the aggregates used were the soda-lime (albite-anothite) series of feldspars as well as microcline and anorthoclase. Similar experiments were made with aggregates from some rocks of mixed mineralogical composition.

It was found that the mineral composition of the aggregate influenced greatly the strength attained on autoclaving and to a lesser extent that attained at room temperature.

MASS PRODUCTION OF PRESTRESSED STRUCTURAL CONCRETE IN SWEDEN 52-49

HENNING COLLBORG — Mar. 1956, pp. 781-790 (V. 52)

A Swedish factory for production of precast prestressed structural concrete is described. A brief history of the company is followed by a description of materials, design principles, production methods, erection procedures, and administrative organization. Examples of the types of members and structures manufactured, primarily structural frames for industrial buildings, are illustrated.

PHYSICAL INCOMPATIBILITY OF MATRIX AND AGGREGATE IN CONCRETE . . 52-50

G. M. SMITH — Mar. 1956, pp. 791-798 (V. 52)

A theoretical analysis is made of the stresses that might result in a matrix surrounding a sperical body due to the thermal incompatibility of the matrix and the spherical body. The analysis indicates that the magnitude of the stresses depends upon the thermal expansion, Poisson's ratio, modulus of elasticity, and size of the inclusion. Although the analysis is purely qualitative, it does show the complexity of the term "thermal incompatibility," so frequently related to the durability of concrete subjected to freezing and thawing. Graphs are constructed to illustrate the effect of the various physical properties on the thermal stresses developed in a matrix. The matrix is considered to consist of cement paste or a mixture of paste, aggregate, and voids.

YEAR IN REVIEW 52-51

CHARLES S. WHITNEY — Apr. 1956, pp. 817-820 (V. 52)

Retiring ACI President Whitney reviews the Institute's 1955 activity. The year is recalled as one of exceptional progress in all phases of Institute work and progress in several long-awaited projects is reported.

BONNEVILLE DAM STILLING BASIN REPAIRED AFTER 17 YEARS' SERVICE . 52-52

ROY R. CLARK — Apr. 1956, pp. 821-838 (V. 52)

Bonneville Dam has passed approximately 1,000,000 cu ft per sec, believed to be a record for any dam so far as volume of water is concerned. When the project was designed and constructed, 1934 to 1938, the board of consulting engineers in approving the design predicted that the baffles designed to absorb part of the energy of the large annual floods of the Columbia River would require renewal at 15-year intervals. The condition of the concrete in the stilling basin was observed throughout the 17 years following completion, and in 1954 a cofferdam was constructed and one-half of the stilling basin was unwatered. When seen for the first time, the concrete was in better condition than expected, based on divers' reports. Special tests and hydraulic model experiments were conducted to determine to what extent conditions could be improved. Repair work was completed and the cofferdam removed before the 1955 seasonal high water.

DESIGN CONSTANTS FOR BEAMS OF VARIABLE SECTION 52-53

MAX W. STRAUSS — Apr. 1956, pp. 839-850 (V. 52)

An approximate method is developed for computing the fixed-end moments, carry-over factors, stiffness, and rigidity of members of variable sections. The method differs from the usual approach only in that it uses a tabular form for adding increments of the various functions instead of integrating the functions directly. Values of S_l and S_r for various loadings are tabulated.

CRACKING IN REINFORCED CONCRETE FLEXURAL MEMBERS 52-54

ARTHUR P. CLARK — Apr. 1956, pp. 851-862 (V. 52)

Tensile cracks, normal to the tensile stress in reinforced flexural members when loads are applied, were investigated in a series of tests of slabs and beams. Spacing of the cracks was measured, crack widths on the tensile face were determined by the use of Tuckerman optical strain gages, strains in the tensile reinforcement were measured with electric resistance strain gages, and deflections of the specimen were measured with taut wires, and scale devices. Location and extent of cracks were observed and recorded.

Slabs of different widths and beams of different depths and spans, with different bar sizes and percentages of reinforcement in each, were tested under loads applied at the quarter points. Measurement of the width of cracks was confined to that portion of the specimen in which the bending moment was constant.

SPECIFIC VOLUME OF EVAPORABLE WATER IN HARDENED PORTLAND CEMENT PASTES 52-55

L. E. COPELAND — Apr. 1956, pp. 863-874 (V. 52)

The mean specific volume of chemically free water in saturated hardened portland cement pastes was found to be 0.99, independent of the extent of hydration of the cement or the water-cement ratio of the paste. This implies that there is no difference between the specific volumes of gel water and capillary water in saturated pastes. The total pore volume of a hardened paste is thus $0.99w_e$. The conclusion of Powers and Brownyard that gel water was more dense than capillary water resulted from determining the specific volume of the solids in hardened pastes by a helium-displacement method.

The specific volume of the hydration products, 0.398, determined in this work agrees well with the 0.392 obtained by Powers and Brownyard using the water-displacement method.

The amount of water that a paste must absorb to remain saturated while the cement is hydrating is given by the equation: $w_t - w_o = 0.25w_n$.

INVESTIGATION OF STUD SHEAR CONNECTORS FOR COMPOSITE CONCRETE AND STEEL T-BEAMS....52-56

I. M. VIEST — Apr. 1956, pp. 875-892 (V. 52)

Push-out tests of round steel studs were made to determine the behavior and load carrying capacity of stud shear connectors. The tests have shown that a steel stud is suitable for use as a shear connector in composite concrete and steel construction. Empirical equations are presented for determining critical load.

BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-56) 52-57

COMMITTEE 318 — May 1956, pp. 913-986 (V. 52)

Supersedes 47-43 and 52-26

This code covers the proper design and construction of buildings of reinforced concrete. In such structures as arches, tanks, reservoirs, and chimneys where specialization relates principally to the mechanics of design and details of construction, the provisions of this code may be applied with the modification necessary to suit the special conditions. It is written in such a form that it may be incorporated verbatim or adopted by reference in a general building code, and earlier editions of it have been widely used in this manner.

Among the subjects covered are: quality of concrete; allowable stresses; mixing, placing, curing, and cold weather protection of concrete; forms; cleaning, bending, placing, splicing, and protection of reinforcement; embedment of pipe and conduits in concrete; construction joints; general design considerations; flexural computations; shear and diagonal tension; bond and anchorage; flat slabs; columns and walls; footings; and precast concrete. The quality and testing of materials used in the construction are covered by references to the appropriate ASTM standard specifications.

BASIS FOR CLASSIFYING DELETERIOUS CHARACTERISTICS OF CONCRETE AGGREGATES MATERIALS 52-58

E. G. SWENSON and V. CHALY — May 1956, pp. 987-1002 (V. 52)

Deleterious characteristics of concrete aggregate materials are reviewed, and a simplified arrangement for their classification is proposed. This arrangement is based on a recognition of harmful properties rather than on types of materials, thus providing the testing engineer with a more systematic basis for laboratory evaluation of aggregates. Harmful properties that involve chemical action are given the same emphasis as those involving the physical nature of the material. These properties are discussed in relation to the limitations of conventional methods of test and the need for supplementary testing based on petrographic and chemical techniques.

MANUFACTURING METHODS IN CONSTRUCTION 52-59

DONALD M. MacLEAY — May 1956, pp. 1003-1012 (V. 52)

Pier No. 57 on the Hudson River in New York City has received considerable publicity due to its unique design. Of particular interest to the construction industry are the manufacturing methods employed in the fabrication of the 3148 precast, prestressed concrete stringers. The pretensioning method was selected. Casting beds, forms, tensioning equipment, and manufacturing procedure are described.

RECOMMENDED PRACTICE FOR WINTER CONCRETING (ACI 604-56) 52-60

COMMITTEE 604 — June 1956, pp. 1025-1048 (V. 52)

Supersedes 45-1 and 52-9

Air-entrained concrete and addition of 1 percent of calcium chloride by weight of cement are recommended in cold weather. They permit a reduction in the time newly placed concrete should be protected. The use of accelerators and antifreezes, keeping of temperature records, heating of materials, subgrade preparation, protective coverings, heated enclosures, curing, and form removal are discussed for several types of concrete structures and preferred methods are indicated. Supplementary material on the effect of curing temperature on concrete strength are given in an appendix. A list of selected references is included.

TENSILE CRACK EXPOSURE TESTS OF STRESSED REINFORCED CONCRETE BEAMS 52-61

THOMAS B. KENNEDY — June 1956, pp. 1049-1064 (V. 52)

Eighty-two reinforced beams were made of concrete with a nominal compressive strength of 3500 psi at 28 days. Air-entrained and non-air-entrained concrete were used. Seventy-four beams were reinforced with rail-steel bars, of which 64 had deformations conforming to ASTM A 305-50T and ten had old-style deformations. Eight beams were reinforced with billet-steel bars having deformations conforming to ASTM A 305-50T. Coverage over the steel was either ¾ in. or 2 in. and bars were placed in either bottom or top position when the concrete was placed. Seventy-two beams were stressed from 20,000 to 50,000 psi by third-point loading and in the loaded condition exposed to severe natural weathering at half-tide elevation on the beach at Treat Island, Cobscook Bay, Me. Ten control specimens were exposed but not loaded.

Results after three winters exposure indicated that only air-entrained concrete specimens are sufficiently durable to withstand this type of exposure. Evaluation of the test results was based on the condition of the specimens after two winters exposure because of the rapid deterioration of the non-air-entrained concrete beams which constituted the majority of the specimens in the program.

Specimens with bars having deformations complying with ASTM A 305-50T performed more satisfactorily than did those with old-style deformations. There was no distinguishable difference in the performance of the specimens reinforced with rail-steel or billet-steel bars. Deterioration appeared to increase with increasing stress in the steel only for the non-air-entrained concrete. Effect of position of steel, whether at top or bottom at the time of casting, was not apparent in the air-entrained concrete specimens. In the non-air-entrained concrete specimens those with steel at the bottom at time of casting were more durable than those with steel at the top. No effects of depth of protective concrete over the reinforcing steel were revealed.

BUILDING FRAMES IN PRESTRESSED CONCRETE 52-62

DAVID P. BILLINGTON — June 1956, pp. 1065-1082 (V. 52)

Three important variables in the design of economical prestressed concrete building frames are: (1) tendon profile, (2) girder cross-section, and (3) girder profile. The action of each variable on the effectiveness of the frame in carrying its load is considered. Types of frames considered are those in which (1) frame is post-

tensioned, (2) girder only is prestressed, and (3) prestressing force is constant throughout girden length. Criteria are offered for selecting an efficient framing system for detailed frame analysis.

AUTOGENOUS HEALING OF CEMENT PASTE 52-63

KENNETH R. LAUER and FLOYD O. SLATE — June 1956, pp. 1083-1098 (V. 52)

It is recognized that cracks in concrete sometimes become "healed." The cracks are partially or completely filled, and the strength properties become greater than in the cracked concrete.

A study of the nature of the healing action is reported, and of the increases in tensile strength measured perpendicular to the plane of the crack. Study was made of effects on healing of time of healing, conditions of curing, additions of lime and of fly ash, and cycles of wetting and drying.

Healing action is caused by the formation of crystals of calcium carbonate and calcium hydroxide in the cracks. Healing can increase tensile strength from 0 psi to 25 percent of normal tensile strength. It occurs far more rapidly under water than in air. Additions of lime and fly ash have little effect.

ANALYSIS AND TESTING OF TRANSLATIONAL SHELLS 52-64

MARIO G. SALVADORI — June 1956, pp. 1099-1114 (V. 52)

The general theory of thin translational shells was developed by Pucher and Flugge. The finite difference approach of Pucher is applied to the analysis of translational shells generated by arcs of circles. Formulas are obtained for the analysis of rectangular shells and are applied numerically to a square shell. Tests to destruction were conducted in Piacenza, Italy, on a shell of this type, 30 x 45 ft. Tests of this reinforced concrete and tile shell prove the validity of the assumptions and results of this analysis.

AIR ENTRAINMENT IN MORTARS....52-65

G. M. BRUERE — June 1956, pp. 1115-1124 (V. 52)

The air-entraining capacities of a series of surface-active agents were measured in a group of mortars. Results show that the conditions of formation of stable air-entrained mortars by means of surface-active agents are similar to those in cement and silica pastes.

Proceedings V. 53

STRUCTURAL DESIGN CONSIDERATIONS FOR PAVEMENT JOINTS 53-1

SUBCOMMITTEE III, COMMITTEE 325 — July 1956, pp. 1-28 (V. 53)

Considerations are presented for the structural design of joints in concrete pavements for highways and airports. A description, function, and classification of joints, assumptions and materials to be used, and joint design details are included. Special consideration is given to applicable design criteria for tie bars and dowels.

SHEARING STRENGTH OF REINFORCED CONCRETE SLABS.....53-2

RICHARD C. ELSTNER and EIVIND HOGNESTAD — July 1956, pp. 29-58 (V. 53)

Presented as a research report without practical design recommendations, this paper reports the methods and results of experimental work on the shearing strength of reinforced concrete slabs subjected to a centrally located, concentrated load. Tests of thirty-nine 6-ft square slabs are reported. For 34 slabs, final failure was in shear by the column punching through the slab, in most cases after initial yielding of the tension reinforcement.

Major variables were: concrete strength, percentage of tension reinforcement, percentage of compression reinforcement, size of column, conditions of support and loading, distribution of tension reinforcement, and amount and position of shear reinforcement.

The test findings show that the shearing strength of slabs is a function of concrete strength as well as several other variables. An ultimate strength theory was developed, by which the slab behavior under load may be explained and the measured ultimate loads may be predicted with satisfactory accuracy.

PRESTRESSED CONCRETE PAVEMENT FOR AIRFIELDS 53-3

THOMAS CHOLNOKY — July 1956, pp. 59-84 (V. 53)

Construction and testing of a 500 ft long and 12 ft wide experimental prestressed concrete slab are described. Loads on the prestressing tendons, development of prestressing in the slab, its load-carrying capacity, and the effect of heat thereon were studied. The results proved the superior behavior of the slab in all respects, and indicated that such construction could be utilized in future airfield pavement construction.

EARTHQUAKE RESISTANT DESIGN BASED ON DYNAMIC PROPERTIES OF EARTHQUAKES 53-4

G. W. HOUSNER — July 1956, pp. 85-98 (V. 53)

A method of earthquake resistant design is proposed that takes into account the dynamic properties of earthquake ground motion and the dynamic properties of the structure. The method is applied to reinforced concrete cantilever chimneys and by appropriate simplifications the method is made sufficiently simple to be usable in ordinary design practice. The bending moments and shears given by this method differ markedly from those given by the percent *g* method of design. In particular, they give more economical designs for tall, flexible chimneys.

STRUCTURAL ANALYSIS BY DYNAMIC LOAD PARAMETERS......53-5

JAMES A. CHENEY — July 1956, pp. 99-112 (V. 53)

Summarizes the method of normal modes which may be used in the analysis of structures under blast and earthquake excitation. Solutions are simplified to give equations involving several basic nondimensional parameters. Application is made to a reinforced concrete building under earthquake and blast loading.

SPACING OF REINFORCEMENT IN BEAMS 53-6

S. J. CHAMBERLIN — July 1956, pp. 113-134 (V. 53)

The effect of spacing of parallel bars was studied in modified beams. Simulated variations in spacing were obtained by varying the width of the concrete at the steel in different specimens. Two-point symmetrical loading was used on one- and two-bar specimens made with two different concretes. Steel consisted of #4 bars — plain, old-style deformed, and modern deformed, and one modern #6 bar. Embedded length-diameter ratios varied from 6 to 21.33. Bar slippages at the load points and at the free ends, deflections, and steel strains were measured. Ultimate loads increased with wider spacing until tensile failures developed. Measured bar slippages were greater for the narrowest spacing than for the others. All plain-bar beams failed by excessive slippage of the steel. Deformed-bar beams which did not fail in tension failed either by rupture of the concrete along a horizontal plane at the center line of the steel or in combination with diagonal tension. Results indicate that an effective clear spacing of three bar diameters may be required.

CONSIDERATIONS FOR CONSTRUCTION OF SUBGRADES AND SUBBASES FOR RIGID PAVEMENT 53-7

SUBCOMMITTEE I, COMMITTEE 325 — Aug. 1956, pp. 145-156 (V. 53)

The approach to the study of subgrades and subbases is motivated by economy in solving pavement problems created by nationwide variation in soil types. The major problems of concern in the design of rigid pavements are discussed.

Soil classification and its limitations are discussed, the bases for the most popular systems are described briefly. The major properties that should be ascertained before a material is used as an integral member of the pavement system are considered and methods of

tests are referenced to standard specifications. Subbases are discussed from the standpoint of use in rigid pavement systems as well as their requirements for satisfactory service.

SOME IMPLICATIONS OF RECENT DIAGONAL TENSION TESTS........53-8

PHIL M. FERGUSON — Aug. 1956, pp. 157-172 (V. 53)

On the basis of the observed cracking which occurs when a beam fails in diagonal tension without stirrups and away from complicating loads and reactions, a hypothesis of restrained failure is developed. This hypothesis assumes each step in the cracking pattern as a tension failure which can be rationalized in terms of the conventional combined stress formula.

Failures of beams somewhat restrained by reactions or loads, of beams of large shear span, and of footings are discussed in terms of this hypothesis.

Finally, two exploratory series of tests are reported. The first investigates the effect of extra or multiple loads and suggests that higher shear strengths are available near supports. The second series indicates that much of the increased capacity associated with small shear spans is lost if the loads are applied as shears over the depth of the beam or if the reaction is applied as a shear.

CONDUCTION CALORIMETER FOR MEASURING HEAT OF HYDRATION OF PORTLAND CEMENT AT ELEVATED TEMPERATURES AND PRESSURES.....53-9

N. C. LUDWIG and S. A. PENCE — Aug. 1956, pp. 173-184 (V. 53)

An apparatus for measuring continuously the rates and total amounts of heat liberated when cement composition and water react at temperatures in the range of 80 to 350 F and at pressures from atmospheric to 10,000 psi is described. The method of calibration and test procedure are given.

Typical test results obtained on portland cement pastes cured at 100 F and at various pressures show that the rates and total amounts of heat liberated are increased by pressure at early ages.

BHAKRA DAM — DESIGN AND CONSTRUCTION FEATURES 53-10

C. L. HANDA and O. P. CHADHA — Aug. 1956, pp. 185-204 (V. 53)

The Bhakra Nangal project is one of the multipurpose projects being constructed in India for irrigation and power. Major feature of the project is Bhakra Dam, a 680 ft high gravity concrete structure. General design features of Bhakra Dam are described including geology of the dam site, layout, galleries, outlets and spillway, and foundations.

In the section on construction of the dam, aggregate cooling, temperature control of the concrete to minimize cracking, mix proportioning, plant layout, and concreting setup are described. Considerable attention is given to the raw materials, particularly the aggregate and pozzolans, and another section covers various concrete investigations.

AN EXPRESSION FOR CREEP AND ITS APPLICATION TO PRESTRESSED CONCRETE 53-11

CEVDET Z. ERZEN — Aug. 1956, pp. 205-214 (V. 53)

A simple expression for total strain (elastic plus creep) is given. The equation for the total strain is then used in determining the loss of stress in the prestressed beams due to creep of concrete. Resulting analysis indicates that the losses in the prestressed beams may be calculated if the variation of modulus of elasticity of concrete with time and the creep equation of concrete are known.

EMPIRICAL TIME-STRENGTH RELATIONS OF CONCRETE 53-12

MYRON L. GORAL — Aug. 1956, pp. 215-224 (V. 53)

Modern design concepts and intense competition with other structural materials make it necessary for the contractor of concrete structures to safely improve methods of scheduling concreting operations. Anticipation of the age at which concrete will be sufficiently strong for subsequent operations enables the contractor to plan equipment and personnel in advance of needs and to substantially reduce waiting time. Time-strength forecasting is of particular value in the scheduling of form stripping, removal of shores, handling or erecting precast structural elements, and transferring prestressing forces.

STRENGTH OF A CONCRETE SLAB PRESTRESSED IN TWO DIRECTIONS.53-13

A. C. SCORDELIS, K. S. PISTER, and T. Y. LIN — Sept. 1956, pp. 241-256 (V. 53)

Elastic behavior and ultimate strength of a full size concrete slab prestressed in two directions were investigated. Prestressing was accomplished by means of unbonded post-tensioned cables. The slab was supported only at the four corners, simulating a lift flat slab. It was loaded uniformly by means of air pressure in plastic bags. Experimental deflections and strains were checked against classical elastic theory. Observed ultimate strength was compared to that obtained by the crack-line theory as applied to prestressed slabs.

LINING OF THE TECOLOTE TUNNEL. .53-14

E. R. CROCKER — Sept. 1956, pp. 257-276 (V. 53)

Special problems encountered in excavating and concrete lining the Tecolote Tunnel near Santa Barbara, Calif., are described. The main problem was inflow of water up to 9000 gal. per min at temperatures which reached 117 F. Methods of overcoming problems, among the most difficult in Bureau of Reclamation construction undertakings are described, and information on concrete materials, mixes, and placing procedures is presented.

THEORY OF THE STRESSES INDUCED IN REINFORCED CONCRETE BY APPLIED TWO-DIMENSIONAL STRESS 53-15

BRUCE H. FALCONER—Sept. 1956, pp. 277-294 (V. 53)

Presents a theory of the stresses which are induced in concrete, reinforced in up to two directions, when under applied two-dimensional stress. It is based on convenient simplifying assumptions of the modes of failure. These assumptions are that failure will occur when either redistributions of internal stress cannot relieve tensions greater than yield in the reinforcement, or when induced compressions in the concrete exceed the ultimate compressives strengths of plain concrete.

Although the actual stresses within reinforced concrete are, in general, indeterminate under given loadings, it is shown that the stresses lie within computable regions of magnitude. Consequently, the theory can be used for the computation of quantities and orientations of reinforcement which are consistent with desired ultimate strength. This application should prove useful in planning the reinforcement of shear walls, deep beams, and normal beams. As a particular and illustrative case of the theory, consideration is given to the reinforcement of concrete to carry shear plus axial load. An explanation is offered for the experimentally observed high shear strengths of lightly stirruped beams.

In an appendix the theory is applied to a consideration of the strengths of normal or "shallow" reinforced concrete beams, in which the longitudinal reinforcement is customarily located only near the top and bottom of the cross sections. The theory, as applied, purports to predict the shear strengths of "ideally reinforced" beams with given percentages of web reinforcement, presuming that the reinforcement has marked yield stresses. A comparison is given with the results of tests conducted at the University of Illinois.

SOME EFFECTS OF CARBON DIOXIDE ON MORTARS AND CONCRETE.....53-16

I. LEBER and F. A. BLAKEY — Sept. 1956, pp. 295-308 (V. 53)

Tests have been made to determine the effect of gaseous carbon dioxide on the strength and shrinkage of mortars and concretes. Results from work previously

published appeared somewhat contradictory, but it now seems that the strength is increased and shrinkage decreased if specimens undergo a period of curing in carbon dioxide immediately after demolding.

On the other hand, an immediate sharp increase in shrinkage is recorded if specimens are allowed to dry for several days before carbon dioxide treatment is started. The contraction does not continue with time, but appears to be stablized.

The influence of carbon dioxide under pressure, and of storage in air free from carbon dioxide were studied briefly. Some consideration has been given to the way in which the gas is bound by the cement.

ANALYSIS OF INELASTIC BENDING STRESS IN CONCRETE BEAMS 53-17

JAMES M. PRENTIS — Sept. 1956, pp. 309-318 (V. 53)

A method is given for determining the inelastic bending stresses in a concrete beam as it is tested to destruction. It is necessary only to measure the strain distribution in the concrete at a succession of load stages. The steel force is also deducted from these readings. A sample calculation illustrates the method.

DESIGN CONSIDERATIONS FOR CONCRETE PAVEMENT REINFORCEMENT FOR CRACK CONTROL 53-18

SUBCOMMITTEE IV, COMMITTEE 325 — Oct. 1956, pp. 337-362 (V. 53)

Considerations pertinent to the design of distributed reinforcement for crack control have been suggested. Attention has been devoted to characteristics of subgrade frictional resistance, and to the relation between steel stress and crack width.

A rational method for determining coefficient of subgrade friction is advanced which follows conventional lines.

AUDITORIUM FRAMED WITH PRESTRESSED ROOF GIRDERS 53-19

ERIC C. MOLKE — Oct. 1956, pp. 363-374 (V. 53).

Design and construction features of 146-ft roof girders for Springfield, Mo., high school auditorium are discussed. Cast of 5000-psi concrete and prestressed on the ground, the girders were raised between twin concrete columns by the same jacks used for prestressing. Girders were simply supported temporarily while precast roof panels were erected, and frame continuity was later introduced by prestressing the girders to the columns. Stability requirements during construction as well as for the completed structure are considered.

PROPERTIES OF LIGHTWEIGHT AGGREGATES AND LIGHTWEIGHT CONCRETES 53-20

G. W. WASHA — Oct. 1956, pp. 375-382 (V. 53)

Presents condensed history of use of lightweight aggregate. Lightweight concrete is divided into: cellular or foam concrete; no-fines or "popcorn" concrete; and lightweight-aggregate concrete. Properties of lightweight concrete are summarized. Lightweight aggregates, both mineral and vegetable, are enumerated, and the desirable and actual properties of lightweight mineral aggregates are discussed in some detail.

STRUCTURAL LIGHTWEIGHT-AGGREGATE CONCRETE 53-21

RALPH W. KLUGE — Oct. 1956, pp. 383-402 (V. 53)

Properties of structural lightweight-aggregate concrete are treated, including a discussion of the proportioning and control of concrete mixtures containing lightweight aggregate, some of the physical characteristics of plain concrete, as well as certain structural properties of reinforced lightweight concrete with comments on their relation to the design of structural elements. This is an attempt to gather together all of the related data available, both published and unpublished, and presents this information as a guide in the use of lightweight aggregates for structural concrete.

HELICOIDAL STAIRCASES OF REINFORCED CONCRETE 53-22

VICTOR R. BERGMAN — Oct. 1956, pp. 403-412 (V. 53)

The analysis of a helicoidal staircase involves torsional moments as well as bending moments and shears and is consequently somewhat more difficult than that of a straight staircase. However, if the staircase is reduced to its horizontal projection, the problem becomes quite tractable since it resolves itself into that of a fixed-end, curved beam loaded normal to its plane of curvature.

This paper covers determination of the bending moment, torsional shearing stress, shear reinforcement, longitudinal reinforcement, and design at the supports.

FATIGUE TESTS OF PRE-TENSIONED PRESTRESSED BEAMS 53-23

A. M. OZELL and E. ARDAMAN — Oct. 1956, pp. 413-424 (V. 53)

Fatigue tests were conducted to determine the behavior of pretensioned concrete beams prestressed with 7/16 in. seven-wire strands. Eight beams, 6 in. x 8 in. x 20 ft, with a center load, were tested to obtain some solutions to the following questions: Is the use of 7/16 in. seven-wire strand feasible from the standpoint of repetitive loads? Does a beam pretensioned with 7/16 in. strand fail in fatigue because of bond failure in the concrete or by breaking in the strand? What is the magnitude of changes in the load-deflection characteristics influenced by fatigue damage? What amount of permanent set does a beam undergo when subjected to repetitive loads?

Pilot test results indicated that: (1) the use of 7/16 in. seven-wire strands is feasible, (2) the failure of the beams was due to the breaking of wires in the strands by fatigue, (3) load-deflection relationship was affected slightly during the first 30,000 cycles but greatly just prior to failure of the beam, (4) the permanent set was also small at first but increased appreciably just before failure. Results further indicated that no shear cracks were developed near the supports during the fatigue tests. It was possible to draw a load-versus-failure-cycle diagram from the data obtained in these tests.

CONSIDERATIONS IN THE SELECTION OF SLAB DIMENSIONS 53-24

SUBCOMMITTEE II, COMMITTEE 325 — Nov. 1956, pp. 433-454 (V. 53)

The principal dimensions of a pavement slab are length, width, and thickness. These dimensions and the factors which determine them are discussed separately and typical examples are given of the determination of slab thickness for specific sets of conditions.

GUIDE FOR ULTIMATE STRENGTH DESIGN OF REINFORCED CONCRETE 53-25

CHARLES S. WHITNEY and EDWARD COHEN — Nov. 1956, pp. 455-490 (V. 53)

This paper is intended to serve as a supplement to the ACI Building Code (ACI 318-56) which permits the use of the ultimate strength method for the design of reinforced concrete members. It presents the method in its simplest form with working equations and charts to aid in their application. It aims to give the designing engineer all the information that he needs for the use of the ultimate strength method in accordance with the recommendations of the report of the ACI-ASCE joint committee on ultimate strength design.

Regarding those problems not covered by the Code such as consideration of shear, bond, and deflections, recommendations are made based on the writers' practice.

LIGHTWEIGHT AGGREGATES FOR CONCRETE MASONRY UNITS 53-26

C. C. CARLSON — Nov. 1956, pp. 491-508 (V. 53)

The role of mineral lightweight aggregates in the production and utilization of concrete masonry units is discussed. Differences between lightweight and heavyweight aggregates having influence in block manufacturing procedure are cited and the means for

accommodating them are given. Various physical properties of lightweight aggregate concrete masonry wall construction are described and compared to those of heavyweight aggregate. Some mention is made of special uses of lightweight aggregate masonry units for precast and cast-in-place floors and roofs.

INSULATING CONCRETES 53-27

R. C. VALORE, JR. — Nov. 1956, pp. 509-532 (V. 53)

Mix proportioning, mixing method, and physical properties are reviewed for insulating concretes of the types in which structural properties are secondary to thermal insulation value. Densities for four compressive strength ranges are given. Thermal conductivity data from different sources are compared as a function of density. Data are reviewed on other strength properties — elasticity, water absorption, frost resistance, drying shrinkage, and thermal expansion.

Properties often considered in relation to insulating concretes are fire resistance, sound insulation, and sound absorption. Data are given on these properties for lightweight aggregate concretes generally and for concretes used primarily for thermal insulation. The sections on mechanics of sound insulation and absorption are intended to dispel some misconceptions on these subjects in relation to other physical properties of concrete.

PRESTRESSED BRIDGE DESIGNED FOR CRANE LOAD AT NIAGARA RIVER WEIR.............53-28

A. M. LOUNT — Nov. 1956, pp. 533-544 (V. 53)

Cranes which operate gates of a control weir on the Niagara River cause heavily eccentric live loading on the 1512-ft supporting bridge. Bridge designer selected a homogeneous grid system of longitudinal girders tied together by diaphragms, covered with a 7-in. slab acting compositely with the longitudinal girders. All components of the grid are prestressed. Design considerations of transverse bending stiffness and torque rigidity are discussed, and step-by-step method for exact structural analysis of the grid is summarized. Construction features are treated briefly with emphasis on shear connectors, stirrup spacing, and prestressing system.

PARTICLE INTERFERENCE IN CONCRETE MIXES 53-29

B. J. BUTCHER and H. J. HOPKINS — Nov. 1956, pp. 545-556 (V. 53)

C. A. G. Weymouth's theory of particle interference postulates that fine particles infiltrate into the voids of larger particles. The authors' examination of Weymouth's method of calculation has shown his results to be in conflict with recognized physical laws. They advance a new method of applying the Weymouth criterion for particle interference in concrete mixes, based on a consideration of the complete grading of solids instead of applying the criterion in turn to each successive size group.

PROPOSED RECOMMENDED PRACTICE FOR EVALUATION OF COMPRESSION TEST RESULTS OF FIELD CONCRETE..53-30

COMMITTEE 214 — Dec. 1956, pp. 561-580 (V. 53)

Superseded by 54-1

Statistical methods provide valuable tools for assessing results of strength tests, and such information is also of value in refining design criteria and specifications. The report discusses briefly the numerous variations that occur in the strength of concrete and presents statistical methods which are useful in interpreting these variations. Criteria are offered that can be used to establish specifications and maintain required uniformity.

MACKINAC BRIDGE PIER CONSTRUCTION 53-31

R. E. DAVIS, JR. and C. E. HALTENHOFF — Dec. 1956, pp. 581-596 (V. 53)

Construction of the Mackinac Bridge, which will link the upper and lower peninsulas of Michigan, utilized the prepacked method for placing over 400,000 cu yd of concrete in the substructure.

Coarse aggregate for the concrete was placed directly in the cofferdams or caissons by self-unloading ships at rates of up to 2500 tons per hr. The voids in the coarse aggregate were intruded with heavily sanded grout which was pumped from a floating mixing plant. By such grouting, prepacked concrete, containing as little as 2.4 sacks of cement per cu yd for a compressive strength of 3000 psi, was produced at a maximum of 6250 cu yd per day.

ULTIMATE FLEXURAL ANALYSIS BASED ON STRESS-STRAIN CURVES OF CYLINDERS 53-32

G. M. SMITH and L. E. SMITH — Dec. 1956, pp. 597-610 (V. 53)

Describes a stress block for ultimate load analysis based on the stress-strain relation of 6 x 12-in. cylinders. The stress-strain relation from a cylinder, which includes a decrease in stress beyond the ultimate, is described by a single continuous function. The function is used to compute the total compressive force in the compression zone, position of neutral axis, and ultimate moment. The computed values of total compressive force, neutral axis location, and ultimate moment are compared with actual test values of reinforced concrete beams. The mode of failure is predicted for beams of near balanced design.

The approach described leads to a more accurate analysis of beams reinforced with more than one layer of steel.

PROPOSED MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES 53-33

COMMITTEE 315 — Jan. 1957, pp. 617-624 (V. 53)

The manual presents recommended methods and standards for preparing drawings for the fabrication and placing of reinforcing steel in reinforced concrete structures. The previous ACI Standards, ACI 315-51 (detailing of building structures) and ACI 315A-53 (detailing of highway structures), have been combined into one manual.

Typical engineering drawings (and, for buildings, placing drawings as well) illustrate the use of the standards.

RIGID FRAME FAILURES 53-34

BOYD G. ANDERSON — Jan. 1957, pp. 625-636 (V. 53)

The fundamental behavior of concrete members in transferring shear load is not fully understood, and in some cases designs have resulted in costly failures. One such failure occurred when portions of some U. S. Air Force rigid frame warehouses collapsed. General nature of distress is described; materials and construction procedure are analyzed briefly. A critical review of the design suggested some points subject to question. Some general comments are offered on shear design.

LABORATORY INVESTIGATION OF RIGID FRAME FAILURE...........53-35

RICHARD C. ELSTNER and EIVIND HOGNESTAD — Jan. 1957, pp. 637-668 (V. 53)

An experimental investigation into the causes of failure in a rigid frame warehouse is reported. The type of diagonal cracking that caused the failure was reproduced in the laboratory; revised frame designs for future construction were tested; and remedial measures were developed to strengthen existing frames by prestressed steel strapping applied externally.

Though further studies are needed to clarify completely the fundamental mechanism of failure, it is believed that the failure took place by a combination of diagonal tension due to dead load and axial tension due to shrinkage and temperature change. It is considered highly probable that the type of distress involved can be avoided by sufficient web reinforcement, sufficient extension of longitudinal reinforcement beyond the region of contraflexure, and effective expansion joints.

APPLICATION OF STEEL STRAP REINFORCEMENT TO GIRDERS OF RIGID FRAMES, SPECIAL AMC WAREHOUSES 53-36

REINHART R. LUNOE and GEORGE A WILLIS — Jan. 1957, pp. 669-678 (V. 53)

The test applications reported were made to develop a procedure for installing the steel strap reinforcement on full-scale girders in the field, and to work out solutions for any impractical features of the design specifications. Test applications were made on one rigid frame on which the roof deck had been placed and on one rigid frame without the roof deck. Buttering the inside of the corner protection angles with grout prior to clamping the angles in place was found to be the most practical method of insuring uniform bearing between the angles and the concrete girders. A standard model stretcher calibrated by a torque indicator attached to the operating handle is satisfactory for tensioning the straps to a reasonably accurate predetermined stress. Tapping the straps at the corners of the grider both during the tensioning operation and after sealing was necessary to develop higher stresses and to produce more nearly equal stresses in the straps on all sides of the girder.

RECENT INVESTIGATIONS OF THE SYSTEM LIME-ALUMINA-CALCIUM SULFATE-WATER AND ITS IMPORTANCE IN BUILDING RESEARCH PROBLEMS 53-37

WILHELM EITEL — Jan. 1957, pp. 679-698 (V. 53)

The general character of the complex calcium aluminate sulfate hydrates in the quarternary system is outlined on the basis of the previous publications of F. E. Jones and of revised determinations of the concentrations of the equilibrium solutions. New projection methods for the quaternary equilibria are given which are particularly obvious for solutions of low concentrations in lime, calcium sulfate, and alumina hydrate. The importance of unstable crystallizations is emphasized, especially the formation of crystalline solutions of tetracalcium aluminate hydrate and $3CaO \cdot Al_2O_3 \cdot CaSO_4 \cdot 12H_2O$. The use of the revised equilibrium diagram for the explanation of the reactions of sulfate solutions with pozzolans containing hydraulic binders is particularly illustrated. The role of activated alumina in zeolitic weather minerals of pozzolanic and related rock types is emphasized for the correct interpretation of such reactions.

TENSILE SPLITTING TEST AND HIGH STRENGTH CONCRETE TEST CYLINDERS 53-38

SVEN THAULOW — Jan. 1957, pp. 699-706 (V. 53)

Describes an indirect tensile test for determination of tensile splitting strength of concrete and a Norwegian method for preparing cylindrical specimens in which sufficient compaction of the concrete is secured, and capping for compression test is eliminated. This method of making cylinders is particularly valuable for high strength concretes, where thickness and quality of the capping material may have considerable more effect on the compressive strength test results than for lower strength concretes.

PROPOSED RECOMMENDED PRACTICE FOR DESIGN OF CONCRETE PAVEMENTS . 53-39

COMMITTEE 325 — Feb. 1957, pp. 717-750 (V. 53)

Superseded by 55-2

Recommendations are presented for the design of rigid concrete pavement and bases based on practice proved successful in the United States. It offers comprehensive directions to design rigid airport and highway pavements or bases for conditions of climate, traffic, available construction materials and equipment, and construction methods of the United States. It includes recommendations for soil foundations, selection of slab dimensions, joints, and details, for reinforced or nonreinforced pavement. Recommendations for design of cement-stabilized bases, continuously reinforced pavement, prestressed pavement, and rigid resurfacings are not included since their use has not yet developed a generally applicable practice.

SIX STORIES OF PRESTRESSED SLABS ERECTED BY LIFT-SLAB METHOD 53-40

JAMES S. MINGES and DONALD S. WILD—Feb. 1957, pp. 751-768 (V. 53)

Describes construction of a five-story hospital with solarium. Lift slabs are 43 ft x 182 ft x 8½ in. for the first five floors, and 41 ft x 80 ft x 8½ in. for the solarium roof which was lifted 62 ft. Special shear blocks made it possible to hold the slab in its lifted position with 1¾ in. pins during welding. This freed lifting equipment to proceed with the next slab. Columns were 14-in. wide flange sections erected in two parts. Top slabs were lifted to the top of the first section and held temporarily while bottom floors were set in final position. While bottom floors were being welded, the top section of the columns was erected and the top slabs placed in final position.

SHRINKAGE AND TEMPERATURE STRESSES IN MASONRY 53-41

R. E. COPELAND — Feb. 1957, pp. 769-780 (V. 53)

Various methods, including crack control joints, have been proposed for crack control in concrete masonry walls due to shrinkage and temperature stresses. Paper outlines a theory based on experimental studies and experience for determining the maximum permissible distance between control joints in blank walls containing no "stress raisers." The effect of variables such as type and degree of restraint and properties of the masonry units is discussed.

The theory is offered not as a rigorous mathematical treatment of the problem but as an approximate guide for the design engineer and architect.

SOME FACTORS INFLUENCING SHRINKAGE OF CONCRETE PAVEMENTS 53-42

F. N. HVEEM and BAILEY TREMPER — Feb. 1957, pp. 781-790 (V. 53)

Portland cement concrete pavements tend to become rougher with time. To a degree the development of roughness is initiated by curling of the end of the slabs. In California, at least, slabs curl upward more than downward because shrinkage due to drying is more pronounced in the upper part of the slab. When curled upward, the slabs are not supported uniformly by the subgrade and the ends deflect more under load. Under heavy traffic, cracks and faulting develop and the pavement becomes progressively rougher. The integrity and smoothness of the pavement can be prolonged if the characteristic shrinkage of concrete can be reduced.

Both portland cement and aggregates affect the amount of shrinkage. Some of the factors contributing to the influence of portland cement are known, although not adequately restricted in standard specifications. The contribution of clay in aggregates to shrinkage has not received the attention it warrants and national specifications do not guard adequately against excessive amounts of clay.

The California Division of Highways has developed simple, short field tests that evaluate both the quantity and activity of clay contained in aggregates. These are known as the "sand equivalent" and "sedimentation" tests. Data are presented to show that a high degree of correlation exists between the results of these tests and the drying shrinkage of mortar and concrete. With suitable specification limits, these tests are effective in securing important reductions in drying shrinkage.

STUDY OF SHRINKAGE IN CONCRETE FRAMES 53-43

MORGAN B. KLOCK and ROBERT R. SHERIDAN — Feb. 1957, pp. 791-796 (V. 53)

During the planning for a building at the Kodak Park Works in 1939, the question of whether to build the frame in two sections with a contraction joint was thoroughly explored. The total length was to be 275 ft; without a joint it would be one of the longest continuous frames in Kodak's Rochester plants. It was decided to

construct the building as one unit and to undertake a study of shrinkage in the frame.

Carlson electric meters were buried in the concrete in several locations in four slabs, horizontally and vertically. These have provided most of the data which now make up a 16-year record. Drying shrinkage in the order of 500 millionths horizontally and 1000 millionths vertically has been indicated.

PLASTIC SHRINKAGE 53-44

WILLIAM LERCH — Feb. 1957, pp. 797-802 (V. 53)

Plastic shrinkage and plastic shrinkage cracking sometimes occur in the exposed surface of freshly-placed concrete. This shrinkage and cracking is caused by a rapid evaporation of water from the surface of the concrete. Conditions that determine the rate of evaporation are described. Construction procedures and practices that can minimize the causes of this type of shrinkage and cracking are recommended. Specific cases cited show how application of these procedures has solved the problem. It is believed that the recommended corrective measure will solve the problem of plastic shrinkage and plastic shrinkage cracking on construction projects.

DETERMINATION OF CREEP STRAIN OF CONCRETE UNDER SUSTAINED COMPRESSIVE STRESS 53-45

F. EUGENE SEAMAN — Feb. 1957, pp. 803-810 (V. 53)

Presents the many problems involved in the measurement of creep strain in concrete as distinguished from elastic strain and other volume change factors. Describes equipment and procedures developed for the mass accumulation of reliable data necessary to evaluate the variables in concrete. Limited data indicate that curing method may greatly influence the creep strain property of concrete. Creep strain ratio values, for various concrete stresses are plotted against time for maximum creep-time curve.

GUIDE FOR PAINTING CONCRETE. .53-46

COMMITTEE 616 — Mar. 1957, pp. 817-832 (V. 53)

This report describes types of paints, other than portland cement paint, commonly used on concrete. It reviews procedures for preparing the surface, selecting and applying the paint, and for repainting. Dampproofing and waterproofing are discussed briefly. A list of federal specifications for paints suitable for concrete is included.

SHEAR STRENGTH OF REINFORCED CONCRETE FRAME MEMBERS WITHOUT WEB REINFORCEMENT 53-47

JO DEAN MORROW and I. M. VIEST — Mar. 1957, pp. 833-870 (V. 53)

Experimental and analytical studies reported have shown conclusively that the strength of a reinforced concrete frame member without web reinforcement is affected by shear through the formation of diagonal tension cracks. If the percentage of longitudinal reinforcement is small or the shear span is very long, a member without web reinforcement fails in flexure without prior formation of diagonal tension cracks; in such case, strength of the member is unaffected by shear. If, however, a diagonal tension crack forms, the strength of the beam is usually lower than that corresponding to flexual failure. Depending on its make-up, such member may fail either simultaneously with the formation of the diagonal tension crack or it may fail at a higher load. The first type of failure is designated as diagonal tension failure; the second is designated as shear compression failure. The relationship between flexural, diagonal tension, and shear compression failures is discussed in detail.

The tests included 33 knee frames subjected to combination of axial compression, shear, and moment, and 38 stub beams subjected to moment and shear. In all knee frames the axial load was equal to the external shear. The major variables were the length of shear span, the strength of concrete, and the percentage of reinforcement.

Analytical expression are presented for predicting the diagonal tension cracking load and shear compression strength. The diagonal tension cracking load is expressed in terms of the nominal shearing stress, and the shear compression strength is expressed in terms of the shear moment capacity.

STRUCTURAL REFRACTORY CONCRETE 53-48

HERMAN G. PROTZE — Mar. 1957, pp. 871-888 (V. 53)

Theoretical and practical problems in the construction of jet engine test cell exhaust structures are considered, including the development and use of proper materials, mixtures, equipment, and methods for installation of durable structural refractory lightweight aluminous cement concretes. The author draws from laboratory and field experiences on four projects in recommending current optimum techniques for such work.

DESIGN OF FLOATING SLAB FOUNDATION 53-49

NORMAN B. GREEN — Mar. 1957, pp. 889-898 (V. 53)

A method is developed for the stress analysis and design of a floating or monolithic type of slab foundation that supports edge loads. The method is applied to the foundation of a typical one-story wood frame school building. This type of foundation effects a considerable saving in cost over conventional concrete wall footings with a separate floor slab.

RESPONSIBILITIES OF AN INSPECTOR 53-50

GRANT BLOODGOOD and LEWIS H. TUTHILL — Mar. 1957, pp. 899-904 (V. 53)

Describes general principles, attitudes, and approaches appropriate for any inspector, on any size or kind of job. Place of the inspector in the construction engineer's organization is discussed with emphasis on cooperation with fellow inspectors, and the inspector's responsibility to carry out general organization policy whether it agrees with his personal judgment or not. How to maintain friendliness without familiarity keynotes section on relationship of inspector to contractor. Third section deals with direction of the activities of other inspectors.

REVIEW OF ACTIVITIES DURING 1956 53-51

FRANK KEREKES — Apr. 1957, pp. 913-916 (V. 53)

A net gain of 1057 Institute members is reported for 1956. New publications issued during the year are cited, along with expanded Journal publication schedule and revised scheme for publishing discussion of papers and reports. Work of the Standards Committee is reviewed, and new technical committees are described. Progress in planning and financing the proposed ACI headquarters building is summarized.

PROPOSED REVISION OF SPECIFICATIONS FOR CONCRETE PAVEMENTS AND CONCRETE BASES 53-52

COMMITTEE 617 — Apr. 1957, pp. 917-946 (V. 53)

Superseded by 55-3

Specifications apply to construction of portland cement concrete pavements and bases under normal conditions for both highways and airports. Standards and specifications of several other organizations are incorporated by reference.

Sources and acceptance standards for materials are given, as well as materials testing procedures and procedures for test of concrete strength to be used as a basis for proportioninp of mixtures. Specifications for the materials and construction of soil foundations for concrete pavements and concrete bases are included. Provision is made for use of foundations stabilized by a cementing agent, but materials and construction of such are beyond scope of this specification.

Materials, dimensions, setting, and removal of forms are treated. Construction methods are specified for forming joints, installation of joint seal and load transfer devices, and placing of reinforcement. Concrete proportioning based on design for minimum strength is covered in detail; proportioning based on fixed cement content is allowed. Other sections cover

production of high-early-strength concrete and the handling and mixing of materials. Detailed requirements are given for placing, finishing, and curing of pavement concrete. Check of thickness of finished pavement is cited as basis for adjustments in payment to contractor. Protection of finished pavement, opening it to traffic, and public use of thoroughfare during construction are also specified.

TESTS OF A NEW METHOD FOR EVALUATING VOLUME CHANGES OF CONCRETE MASONRY UNITS 53-53

M. W. FERGUSON, G. L. KALOUSEK, and C. W. SMITH — Apr. 1957, pp. 947-960 (V. 53)

A suggested procedure developed by ACI Committee 716 for the accelerated testing of autoclaved concrete block for volume change (by drying previously saturated block at 225 F) has certain limitations if used for testing block cured by different methods. Reversing the procedure of the suggested method, first drying and then saturating the block, yielded results which appeared to cut total time of test nearly 1 day. Autoclaved block re-expanded to equilibrium length in about 4 hr of immersion, whereas the low-pressure steam-cured units continue to expand, often for prolonged periods of time. The new method, therefore, also appears promising for differentiating between block cured by different methods.

ELASTIC DESIGN OF PRESTRESSED SECTIONS IN FLEXURE BY CHARTS OR TABLES 53-54

WITOLD W. ZAWILSKI — Apr. 1957, pp. 961-988 (V. 53)

A method is presented for direct proportioning of the economical shape of cross section; trial and error effort is eliminated, and cross sections need not be modified. Principal concept of design is based on three simultaneous equations in three unknowns expressing loading and stressing conditions. The general equations presented are applicable to any kind of problem.

A rapid design is demonstrated by using charts or tables exemplifying the practical solution of such equations. The charts and tables are based on two fundamental principles of economical design; full utilization of concrete stresses; and full utilization of the lever arm of the internal resisting couple. Accordingly, two types of charts and tables are compiled: (a) for economical use of concrete; and (b) for economical use of steel.

Finally, an economical design by charts and tables is developed for composite cross sections, particularly as applied to bridge decks.

EFFECT OF THE SPECIFIC SURFACE OF AGGREGATES ON CONSISTENCY OF CONCRETE 53-55

B. G. SINGH — Apr. 1957, pp. 989-998 (V. 53)

The specific surface of aggregate for concrete was measured by the water permeability method, and its effect on the consistency of concrete was examined. A wide range of gradings, including extreme gap-gradings, was tested. The range of mix proportions and aggregate normally used in practice was included.

Results show that the specific surface affects the consistency markedly. Aggregate gradings of the same specific surface, for practical purposes, have the same concrete making properties. However, as the specific surface of the aggregate increases, consistency becomes stiffer, other factors being equal.

ANALYSIS OF CONTINUOUS ARCHES ON FLEXIBLE PIERS 53-56

WALTER E. RILEY — Apr. 1957, pp. 999-1012 (V. 53)

Demonstrates the applicability of the moment-distribution method when combined with principles of superposition to the practical analysis of continuous symmetrical arches on flexible piers. The calculations are simple, and all operations of multiplication and division may usually be performed with sufficient accuracy on a 10-in slide rule.

HOT WEATHER CONCRETING PROBLEMS 53-57

COMMITTEE 605 — May 1957, pp. 1025-1032 (V. 53)

This progress report discusses the subject matter which is proposed for inclusion in a recommended practice now being drafted by the committee. It discusses, briefly, effects of concreting in hot weather; factors in minimizing hot weather difficulties, keeping concrete temperature down by controlling the temperature of its ingredients; production and delivery, placement and protection, and concrete testing in hot weather.

TABLES FOR CIRCULARLY CURVED HORIZONTAL BEAMS WITH SYMMETRICAL UNIFORM LOADS. . . 53-58

MARTIN SCHULZ and MAURICIO CHEDRAUI — May 1957, pp. 1033-1040 (V. 53)

These tables will simplify and expedite the engineer's task of calculating circular beams without developing the formulas. Step-by-step derivation of the tables is given.

MORTAR- AND CONCRETE-MAKING PROPERTIES OF NATURAL SANDS RELATED TO THEIR PHYSICAL ATTRIBUTES. . . 53-59

C. F. ZIETSMAN — May 1957, pp. 1041-1056 (V. 53)

Methods for determining mean particle size (fineness modulus), particle size distribution, particle shape, and solid content of natural sands are presented. It is shown how these properties relate to the water requirements of mortars and concretes proportioned by a recognized system.

Using ¾-in. and 1-in. crushed stone as coarse aggregate and proportioning by ACI's recommended practice for proportioning of concrete mixes, at a constant water-cement ratio, it was found that water requirements to produce concrete of a given slump could be predicted to 95 percent accuracy for 95 percent of the sands used in the experiments.

AN IDEA FOR LONG-SPAN PRESTRESSED CONCRETE BRIDGES. . 53-60

E. VAN WALSUM — May 1957, pp. 1057-1066 (V. 53)

An imaginative solution applies prestressing to hyperboloidical and hyperbolic paraboloidical girders for long-span bridges. Problem is treated in a general, nonmathematical form.

DIAGONAL TENSION STRENGTH OF REINFORCED CONCRETE T-BEAMS WITH VARYING SHEAR SPAN 53-61

A. F. AL-ALUSI — May 1957, pp. 1067-1077 (V. 53)

A study of the influence of variations of shear span and percentage of longitudinal steel on mode of failure, cracking strength, and ultimate strength of reinforced concrete T-beams without web reinforcement is reported. Emphasis was placed on beams with large shear spans. The 25 beams tested included only simple-span beams under two symmetrical concentrated loads. The influence of mesh reinforcement in the flange, and that of longitudinal compression reinforcement was also investigated. For a shear span ratio (a/d) between 4.0 and 8.0, the ratios v_u/f_c', ultimate shearing stress to cylinder strength, and v_{cr}/f_c', cracking shearing stress to cylinder strength, were for all practical purposes constant. For the same a/d range, a large increase in the steel area did not affect either the ultimate shearing strength or the cracking strength.

FORM CONSTRUCTION PRACTICES. 53-62

SUBCOMMITTEE II, COMMITTEE 622 — June 1957, pp. 1105-1118 (V. 53)

Subcommittee II, ACI Committee 622 reports on existing practice in construction, design, and use of forms, based on replies to a questionnaire submitted to a selected group of contractors in the United States and Canada. Areas are noted in which contractor efficiency may be improved; architect- or engineer-contractor relationships are treated. Appendix gives detailed summary of answers to questionnaire.

PLASTIC HINGING AT THE INTERSECTION OF BEAMS AND COLUMNS 53-63

G. C. ERNST — June 1957, pp. 1119-1144 (V. 53)

Principal object of investigation was to determine the amount of concentrated plastic rotation developed at the connection between beams and columns. Thirty-three tests were conducted, some at a slow loading rate, some at a fast loading rate equivalent to that prescribed for concrete cylinders. Steel ratios of 0.01, 0.03, and 0.05, column widths of 6, 12, 18, 24, and 36 in., and nominal concrete strengths of 3000 and 4000 psi were used.

Concentrated plastic rotation at concrete crushing and at maximum moment is markedly reduced when the steel ratio exceeds 0.01, and is also less for a fast loading rate. Theoretical moments agreed satisfactorily with experimentally determined moments in all cases. At concrete crushing for the 0.05 steel ratio under fast loading, concentrated plastic rotation was virtually negligible. It seems necessary, therefore, to consider the effect of steel ratio and rate of loading in cases for which the ultimate capacity of a structure is dependent on a redistribution of moment produced by concentrated plastic rotations.

MASS CONCRETE CONTROL IN DETROIT DAM 53-64

ROY R. CLARK — June 1957, pp. 1145-1168 (V. 53)

Planning temperature control procedures for the mass concrete of Detroit Dam in western Oregon is explained in detail. Construction methods, including cooling practices, are given, along with cement types and proportioning of concrete. Temperature history of the mass concrete supplements the analysis of temperature strains in each of four zones of the dam.

Uniformly stable conditions were established at the base of the dam, and inspection 3 years after completion disclosed no defects on the outside surface, and only a few hairline cracks on exposed interior surfaces. Total cost of cooling measures was $0.63 per cu yd, about 4 percent of the total cost of mass concrete.

Proceedings V. 54

RECOMMENDED PRACTICE FOR EVALUATION OF COMPRESSION TEST RESULTS OF FIELD CONCRETE (ACI 214-57) 54-1

COMMITTEE 214 — July 1957, pp. 1-20 (V. 54)

Supersedes 53-30

Statistical methods provide valuable tools for assessing results of strength tests, and such information is also of value in refining design criteria and specifications. The report discusses briefly the numerous variations that occur in the strength of concrete and presents statistical methods which are useful in interpreting these variations. Criteria are offered that can be used to establish specifications and maintain required uniformity.

UNDER-REINFORCED CONCRETE BEAMS UNDER LONG-TERM LOADS 54-2

HERBERT A. SAWYER, JR. and JACK E. STEPHENS — July 1957, pp. 21-30 (V. 54)

Effect of an increase in the time of application of load on both deformations and strength of under-reinforced concrete beams is reported. Intermediate grade steel and concrete of 2500 psi and 5000 psi nominal strength were used for the 14 test beams loaded with gravity-type loads. Increase in term of loading had slight effect on ultimate strength. All test strengths, regardless of term of loading, exceeded strengths calculated by the common ultimate load theories. Increase in term of loading caused important modifications in the moment-curvature relationship, including large increases in concrete strain and beam curvature of ultimate load.

GENERAL METHOD FOR ANALYSIS OF FLAT SLABS AND PLATES..........54-3

JOHN F. BROTCHIE — July 1957, pp. 31-50 (V. 54)

A theory for analysis of moments, shears, and deflections in plates is outlined, and a method developed for its application to flat slab and flat plate structures. The slab is considered as floating on the surface of a liquid; each load and each reaction is applied separately to the floating slab, and these separate effects are summed to give actual moments, shears, and deflections in the structure. Theory is applicable to panels of any shape — square, rectangular, triangular, or trapezoidal — with any type of loading. The method allows for any degree of restraint or fixity between slab and column.

Application of the theory in this paper is limited to internal panels with known column reactions, and tables are presented for the quick determination of moment, shear, and deflection at any point of the panel.

EFFECT OF A WATERPROOF COATING ON CONCRETE DURABILITY 54-4

WARRINGTON G. MITCHELL — July 1957, pp. 51-58 (V. 54)

Common denominator of all generally recognized types of concrete deterioration is water, either in liquid or crystalline form. Since concrete is characteristically a porous material, improvements in concrete itself are not likely to completely prevent ingress of potentially harmful water. Author believes waterproof coatings can speedily and economically improve concrete durability.

Freeze-thaw tests on beams coated with neoprene latex showed significantly greater durability than that of uncoated specimens. Five-hr sand-blast test demonstrated improved abrasion resistance of neoprene-latex coated specimens.

CONTROL JOINTS REGULATE EFFECTS OF VOLUME CHANGE IN CONCRETE MASONRY 54-5

G. A. MANSFIELD, C. A. SIRRINE, and BENJAMIN WILK — July 1957, pp. 59-70 (V. 54)

Practical and easily applied methods of control jointing in use throughout Michigan virtually eliminate visible evidence of volume change in concrete masonry. If used wherever points of weakness are expected to develop noticeable cracking, these precautionary measures act to regulate crack location in a satisfactory and acceptable manner. Undesirable fractures in concrete masonry will occur rarely, if at all, when good construction practice, embodying an effective control joint procedure, is followed in conjunction with structurally adequate design and proper achitectural details.

PROPOSED TEST PROCEDURE TO DETERMINE RELATIVE BOND VALUE OF REINFORCING BARS 54-6

COMMITTEE 208 — Aug. 1957, pp. 89-104 (V. 54)

Superseded by 55-1

This test procedure provides a uniform basis for comparison of bond qualities of different reinforcing bars. The recommended test method uses companion beam type specimens, cast horizontally in inverted and normal positions so that the effects of water gain and settlement of concrete are included in the evaluation. The concrete surrounding the bars is in tension as bars are ordinarily used, which makes the results more acceptable to some users. Minimum criteria for acceptance are not included since the purpose is merely to establish relative bond values for the different bars under consideration.

The test may be used to evaluate the effectiveness of deformed bars having characteristics other than those described in "Tentative Specifications for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement," ASTM A 305-56T. For construction under the ACI Building Code, an evaluation of such bars is necessary since the code definition for a deformed bar is one which meets the requirements of ASTM A 305. Manufacturers of bars meeting

the requirements of ASTM A 305 may use the test procedure for product improvement and to evaluate modifications in the design of deformations.

DESIGN OF CONCRETE FLOORS ON GROUND FOR WAREHOUSE LOADINGS 54-7

PAUL F. RICE — Aug. 1957, pp. 105-114 (V. 54)

An application of the theory of beams on elastic foundations as developed by Timoshenko and Hetenyi. Representing actual soil conditions more closely, these solutions do not require the usual theoretical assumption of a tensile soil reaction for upward deflections. All results are tabulated to enable designer to select a proper slab thickness for a given load, soil, concrete strength, and layout. Criteria used for a proper slab thickness are avoidance of objectionable cracks and elimination of uplift causing visible vertical movements under warehouse-type vehicles. Although the selection of thickness is based on nonreinforced concrete or concrete containing only distributed (temperature) reinforcement for shinkage, moment values furnished may be used for design as reinforced concrete.

MULTISPAN PRESTRESSED FOLDED PLATE ROOF FOR LANGENDORF BAKERY 54-8

JOHN J. DRISKELL — Aug. 1957, pp. 115-126 (V. 54)

Folded plate roof over the production area of the new Langendorf Bakery in Los Angeles covers an area 171 x 365 ft without interior supporting walls. Roof is all lightweight concrete, 4 in. thick throughout except for thickening at prestressing anchorages. Structural design followed principles of accepted folded plate theory, modified to account for plate deflections and the application of prestressing.

EFFECT OF TOBERMORITE ON THE MECHANICAL STRENGTH OF AUTOCLAVED PORTLAND CEMENT-SILICA MIXTURES. 54-9

L. DEAN SANDERS and W. J. SMOTHERS — Aug. 1957, pp. 127-140 (V. 54)

Mechanical strength of steam-cured neat portland cement and cement-silica mixtures was evaluated by using metal test fixtures designed to simulate the ceramic and metal parts of a high-tension porcelain insulator. Five silica materials were tested as additives to cement: two noncrystalline materials, and three samples of crystalline quartz of differing particle sizes. Conditions of steam curing necessary to bring about optimum strength of the cement-silica mixtures were determined. X-ray diffraction analysis was used to identify the crystalline phases present after curing the cement mixtures. Amount of the platy phase of the hydrate tobermorite formed by the steam curing was found to be a definite indication of the mechanical strength of the cement silica mixtures.

FATIGUE AND STATIC TESTS OF STEEL STRAND PRESTRESSED BEAMS OF EXPANDED SHALE CONCRETE AND CONVENTIONAL CONCRETE 54-10

GENE M. NORDBY and WILLIAM J. VENUTI — Aug. 1957, pp. 141-160 (V. 54)

Tests on 27 beams cast from conventional and expanded shale aggregate concrete, prestressed with steel strand, are discussed. Fatigue tests at various load ranges and number of cycles of load repetition were performed on matched beams manufactured from both aggregates. Steel fatigue failures occurred in three specimens while the other 24 beams performed satisfactorily under fatigue loading. The three fatigue failures occurred when the beams were severely cracked during the repetitive loading; this failure was a result of stress concentrations and abrasion between the strands and the concrete. Those specimens undamaged by the fatigue loading were tested statically to failure, and either flexure or bond failures were recorded. The bond failures indicated that embedment length was the governing factor against failure rather than bond stress as computed from conventional equations.

REVIEW OF CHANGES IN THE ACI BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE 54-11

FRANK KEREKES, Sept. 1957, pp. 185-196 (V. 54)

The philosophy of building codes is treated briefly. Evolution of the ACI Building Code and its contents are reviewed, and then related to teaching and to practice. The changes incorporated in the 1956 Code are summarized.

EXPLANATORY NOTES ON APPENDIX (ULTIMATE STRENGTH DESIGN) TO "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-56)" 54-12

COMMITTEE 318 — Sept. 1957, pp. 197-204 (V. 54)

A series of questions and answers on the appendix ("Abstract of Report of ACI-ASCE Joint Committee on Ultimate Strength Design") to the latest ACI Building Code, ACI 318-56.

LABORATORY TESTS OF PORTLAND BLAST-FURNACE SLAG CEMENTS...54-13

BRYANT MATHER — Sept. 1957, pp. 205-232 (V. 54)

Laboratory tests of samples of portland blast-furnace slag cements, and of the blast-furnace slags and portland cement clinkers used in their manufacture, obtained from each of the mills making it in the United States in 1955, indicate that the then current federal and ASTM specifications provide adequate assurance of performance at least equal to that insured of Type I portland cements by applicable specifications. Portland blast-furnace slag cements, meeting the specifications, frequently have low enough heats of hydration to meet the optional heat of hydration requirement for Type II portland cement of the federal specification.

Specifications for portland blast-furnace slag cements do not insure that they will have moderate sulfate resistance, as required of Type II portland cements. The performance of an experimental portland blast-furnace slag cement containing more magnesia than permitted by the specifications, made with a high-magnesia (9.6 percent) slag, was not found to have been adversely affected. Mortar-bar tests suggest that the presence of the slag in the cement acts to keep expansion due to alkali-aggregate reaction from becoming excessive, even when a highly reactive aggregate is used and the cement contains more than 0.6 percent alkalies calculated as sodium oxide.

DESTRUCTIVE IMPULSE LOADING OF REINFORCED BEAMS 54-14

F. T. MAVIS and M. J. GREAVES — Sept. 1957, pp. 233-252 (V. 54)

Reinforced concrete beams, identical except for grade of reinforcement, were tested by pairs under destructive impulse loads in a unique spring-powered testing machine. Data from each dynamic test were filmed by a high-speed motion picture camera which superimposed continuous oscilloscope records of load and reaction, and photographs of the beams at frequency of 1000 pictures a second. Data such as deflection of beams, crack formation, and time intervals, were also recorded on the motion picture film for repeated projection, microscopic frame-by-frame study, and analysis.

Typical tests are detailed and dynamic behavior phases are identified and interpreted. Differences in behavior of beams under dynamic and static loadings are discussed further under headings of crack pattern and "whiplash," shear distribution and bond failure, steel strain and energy absorption. Bibliography lists 116 pertinent references.

ULTIMATE SHEAR STRENGTH OF REINFORCED CONCRETE FLAT SLABS, FOOTINGS, BEAMS, AND FRAME MEMBERS WITHOUT SHEAR REINFORCEMENT. 54-15

CHARLES S. WHITNEY — Oct. 1957, pp. 265-298 (V. 54)

The method for estimating shear strength proposed in this paper is radically different from that currently

in use, but it appears to be well supported by the results of tests which have covered a wide range of proportions and concrete steel strengths.

The conventional shear formula

$$v = V/bjd = k f_c'$$

is not suitable for use because the shear strength is not a simple function of concrete strength, but depends largely on the amount of flexural reinforcement and its efficiency. Also tests show that because of bond failure due to splitting of concrete, the flexual reinforcement cannot be fully effective if it is too closely spaced.

LIGHTWEIGHT-AGGREGATE CONCRETE FOR STRUCTURAL USE 54-16

J. J. SHIDELER — Oct. 1957, pp. 299-328 (V. 54)

Describes tests employed and results obtained in an investigation of properties of lightweight-aggregate concrete of structural quality. Eight lightweight aggregates and one normal weight sand-and-gravel aggregate are included. The total program includes tests of plain, conventionally reinforced, and prestressed concrete specimens, but except for pull-out tests of reinforcing bars, only the data on plain concrete are given. Data are reported on concrete mix proportions, compressive and flexural strength, modulus of elasticity, bond, creep, and drying shrinkage. Concrete mixes were designed to produce compressive strengths of 3000 psi and 4500 psi with each aggregate, and 7000 to 10,000 psi with three selected aggregates.

Comparing the various concretes on the basis of equal compressive strengths, normal weight sand-and-gravel concrete showed somewhat superior performance in most tests. In many structural applications, however, this superiority will doubtless be overshadowed by advantages resulting from reduced unit weight of the lightweight-aggregate concretes.

CONSTRUCTION OF THE DALLAS MEMORIAL AUDITORIUM 54-17

JACK E. ROSENLUND — Oct. 1957, pp. 329-340 (V. 54)

Main structure of the Dallas Memorial Auditorium has 204 ft diameter, doubly curved roof cast of lightweight concrete in 16 separate pie-shaped sections; roof is supported from 45-ft rigid frames that cantilever from 70-ft columns arranged at the periphery of the auditorium, providing a 300 ft diameter clear area. Paper recounts details and problems of forming the columns, cantilevers, and roof sections as well as general considerations governing their design. Problem of cambering forms to compensate for anticipated deflection is treated, along with proportioning, mixing, and placing of both the lightweight and normal weight concrete.

ULTIMATE TORSIONAL PROPERTIES OF RECTANGULAR REINFORCED CONCRETE BEAMS 54-18

G. C. ERNST — Oct. 1957, pp. 341-356 (V. 54)

Principal object of this investigation was to determine the quantity of transverse steel required to develop the yield point in longitudinal bars placed in the corners of rectangular beams subjected to pure torsion. Eighteen tests are reported six each with #3, #4, or #5 longitudinal bars, one in each corner. Transverse ties were spaced at 28, 14, 7, and 4 in., and also in pairs at 4 in. for each group, all #2 size. One beam in each group contained no transverse reinforcement, and the nominal concrete strength of all groups was 4000 psi.

Results indicate that yield strains can be developed in longitudinal corner bars as well as in transverse ties, resulting in either a diagonal tension type of fracture or a hybrid failure in transverse shear and diagonal tension. Initial cracking corresponded to the failure of unreinforced concrete in torsion for all beams, at an average unit shearing stress of 312 psi. Evidence also developed supporting the concept of transition from elastic to plastic states of stress as the ratio of transverse to longitudinal steel approaches unity.

WINTER CONCRETING TRENDS IN EUROPE 54-19

E. G. SWENSON — Nov. 1957, pp. 369-384 (V. 54)

Postwar labor and economic problems in Europe have led to governmental encouragement of winter construction. This has resulted in extensive, state-supported research on winter concreting, the progress of which is largely reflected in the papers presented by European authors at the RILEM Symposium on Winter Concreting in Copenhagen, February, 1956.

The primary consideration has been the reduction in costs of winter protection of green concrete concurrent with the achievement of better assurance of safety. Research has been directed toward methods of quantitative prediction of frost resistance and of minimum protection requirements. Methods of increasing frost resistance of green concrete have received attention.

Practical developments involve the refinement of existing methods of safe winter concreting, particularly the choice of building types most suitable for winter construction and the utilization of locally available materials.

VARIATION OF MORTAR AND CONCRETE PROPERTIES WITH TEMPERATURE. . . 54-20

J. C. SAEMANN and G. W. WASHA — Nov. 1957, pp. 385-396 (V. 54)

Effects of temperature on strength, stiffness, and toughness of mortars and concretes are given. Two mortars and two concretes varying in cement content, and one lightweight concrete were used in the investigation. Mortar cubes, briquets, cylinders, beams, and concrete cylinders were tested after a 24-hr preconditioning treatment at test temperatures which varied between –70 and 450 F.

Test results at subnormal temperature showed that mortar and concrete properties generally increased as the temperature decreased. Test results at elevated temperatures were not as consistent but in general the properties first decreased as the temperature increased, then increased, and finally decreased. At 450 F the strengths of the mortars and concretes were about equal to those at room temperature, but the moduli of elasticity were considerably lower.

A CRITICAL LOOK AT SLAB DESIGN METHODS 54-21

K. E. McKEE and E. I. FIESENHEISER — Nov. 1957, pp. 397-404 (V. 54)

Curves are presented showing maximum moments in uniformity loaded two-way slabs as calculated under two different basic assumptions. These are: (1) the slabs are isotropic and homogeneous, and (2) the slabs are anisotropic and nonhomogeneous when designed by ACI Methods 1 and 2. A glance at the figures shows the different edge conditions, over the full range of variation of side length ratios. Consideration is limited to rectangular slabs supported on all four sides.

BEARING CAPACITY OF CONCRETE. 54-22

WILLIAM SHELSON — Nov. 1957, pp. 405-414 (V. 54)

Test data obtained in several investigations of the relation between ultimate bearing capacity and the ratio of footing area to loaded area of concrete and rock foundations are summarized. The results show that for the higher ratios (over 10:1), the ACI Code requirements are too conservative. An alternative design formula is proposed.

TEMPERATURE STRESSES IN CONTINUOUS FRAMES 54-23

SAM HASSID — Nov. 1957, pp. 415-420 (V. 54)

Explains briefly a distribution method which has been found useful in analyzing frames subjected to temperature changes.

PROPOSED REVISION OF ACI STANDARD 711-53, MINIMUM STANDARD REQUIREMENTS FOR PRECAST CONCRETE FLOOR AND ROOF UNITS 54-24

COMMITTEE 711 — Dec. 1957, pp. 441-448 (V. 54)

Superseded by 55-4

Minimum standard requirements for single units or multiple element assemblies, to be used in conjunction with ACI 318-56. Covers materials, design principles, manufacture including curing and handling, testing of completed units, installation plans, and special provisions for holes and openings in members. Design

chapter treats such problems as dimensions, allowable deflection, structural concrete topping, reinforcement anchorage and location, and use of lightweight concrete.

FAILURES OF CONCRETE STRUCTURES .54-25

JACOB FELD — Dec. 1957, pp. 449-470 (V. 54)

A historical survey of concrete failures of the last half century in the United States; discusses significant examples without attempting to list all failures. Touches on legal aspects from the Code of Hammurabi through English common law with some observations on present code requirements as they relate to different types of failure. Concrete failures are grouped according to their major causes: design deficiency, drafting and detailing errors, concrete mix, supervision omission, frost protection defects, bearing wall deficiency, foundation deficiency, faulty erection techniques, temperature and shrinkage, secondary stresses and inadequate formwork.

ULTIMATE STRENGTH DESIGN CHARTS FOR COLUMNS CONTROLLED BY TENSION 54-26

TUNG AU — Dec. 1957, pp. 471-480 (V. 54)

Basic design equations for eccentrically loaded concrete columns in this paper are based on the report of the joint ACI-ASCE committee on ultimate strength design. To simplify the design procedure for columns with symmetrical reinforcement or with round cores, design charts were provided in a paper by Whitney and Cohen. While these charts are applicable to eccentrically loaded columns which may be controlled either by tension or compression, it seems that they are not entirely satisfactory for columns controlled by tension due to the close spacing of e/t lines in this range. To meet such need, this paper examines certain omissions in the ACI-ASCE committee report, and presents a new set of design charts for rectangular sections with symmetrical reinforcement and for square and circular sections with spiral reinforcement which are subjected to combined bending and axial loads and controlled by tension.

LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE. CHAPTER 10 — PROGRESS REPORT ON STRENGTH AND ELASTIC PROPERTIES OF CONCRETE 54-27

PAUL KLIEGER — Dec. 1957, pp. 481-504 (V. 54)

Presents strength data through 3 years for laboratory mortar and concrete specimens made using cements of the Long-Time Study. It also presents information on the elastic properties of the concretes as determined by both static and dynamic means, and pulse velocities as determined by the soniscope.

(See also 44-21, 44-26, 44-33, 44-38, 46-17, 47-51, 49-42, 52-13, and 54-59)

INVESTIGATION OF MULTIBEAM BRIDGES 54-28

RENE E. WALTHER — Dec. 1957, pp. 505-526 (V. 54)

Following introductory reference to the load-carrying system of multibeam bridges (theory of the orthotropic plates), reports findings of test series on a large-scale model bridge of prestressed concrete. It is shown that such a bridge can accurately be analyzed as an orthotropic plate. The influence of factors which affect the behavior of the structure — slip between adjacent beams, interaction of shear keys, degree and location of lateral post-tensioning, etc. — have been studied. Empirical formulas for the relationship of the stiffness properties are derived.

PROPORTIONING, CONTROL, AND FIELD PRACTICE FOR LIGHTWEIGHT CONCRETE 54-29

TRUMAN R. JONES, JR. and HENSON K. STEPHENSON — Dec. 1957, pp. 527-536 (V. 54)

The most common problems encountered in batch proportioning, handling, placing, and finishing of structural quality concrete made with uncoated expanded shale and clay aggregates produced in Texas are discussed. Extensive laboratory studies have been made using expanded shale aggregates from three different sources and one expanded clay aggregate. Comments, conclusions, and recommendations are based on observations made in the laboratory, on several major structures in the field, and at several commercial plants manufacturing lightweight aggregate concrete products.

A simple method is presented for the proportioning and control of the concrete batch. Practical solutions are given for certain of the field problems frequently experienced in handling, transporting, and stockpiling the aggregates. Practical suggestions for handling, placing, and finishing of the concrete are also discussed.

TENTATIVE RECOMMENDATIONS FOR PRESTRESSED CONCRETE 54-30

ACI-ASCE COMMITTEE 323 — Jan. 1958, pp. 545-578 (V. 54)

A guide to design and construction of safe, serviceable, linear structural members prestressed with high strength steel. Emphasis is on flexural members — beams, girders, and slabs. Most of the recommendations are applicable to both buildings and bridges. Design chapter treats: loading, allowable stress, prestress loss, flexure and shear, bond and anchorage, composite construction, continuity, end blocks, fire resistance, and cover and spacing of prestressing steel. Concrete, grout, prestressing steel, anchorages, and splices are covered in the section on materials. Construction section includes: transportation, placing, and curing of concrete; forms, shoring, and falsework; placement of prestressing steel and application of the prestressing force; grouting; and handling and erection.

MULTISTORY LIFT-SLAB CONSTRUCTION 54-31

W. SEFTON — Jan. 1958, pp. 579-590 (V. 54)

Outlines the general procedure for lift-slab work, citing main advantages and disadvantages. Describes in some detail the slabs, collars, jacks, fittings, jack rods, columns, and anchorage and foundation problems. Principles governing lifting sequence are noted; an example shows lifting sequence for 12-story building. Cost factors are treated, and current Canadian trends in lift-slab applications are given.

ELEVATED TEMPERATURES OF PORTLAND CEMENT MIXTURES RELATED TO SURFACE REMOVAL 54-32

R. H. HEISKELL, R. H. BLACK, R. J. CREW, and H. LEE — Jan. 1958, pp. 591-604 (V. 54)

The effect of heat on the surface removal of concrete was studied by conducting brush tests on samples which had been subjected to prolonged high temperatures in an oven or in direct contact with an oxypropane flame. Other method of heat treating surface layers of concrete were investigated by direct application of an oxyaluminum torch on the surface and by the exothermic chemical reactions of pyrotechnic compositions placed directly on the surface.

Tests showed that an oven temperature of 1100 F is required to decompose portland cement compounds sufficiently to reduce the resistance of concrete surfaces to abrasive removal methods. The temperatures produced at the surface of concrete by an oxypropane burner varied, depending on the rate of traverse of the flame, from 200 to 800 F. Spalling of concrete surfaces can be accomplished by prolonged flame treatment with an oxypropane or oxyacetylene burner. Flame treating with a moving oxypropane burner gave a temperature of 120-600 F at $1/64$ in. below the surface.

No spalling was observed when an oxyaluminum flame passed over the surface at a speed of 10 ft per min; however, prolonged heating resulted in a rather violent spalling reaction.

LIGHTWEIGHT STRUCTURAL CONCRETE PROPORTIONING AND CONTROL . . 54-33

GEORGE H. NELSON and OTTO C. FREI — Jan. 1958, pp. 605-622 (V. 54)

Physical properties and gradation of an expanded shale aggregate produced in Georgia are given. Effect of fine aggregate:coarse aggregate ratio and effect of entrained air on properties of lightweight structural concrete are discussed. Recommends optimum air content for maximum strength of lightweight concrete with from 3 to 9 sacks of cement per cu yd. Proposes a proportioning method which makes use of a specific gravity factor. Using this proportioning method with aforementioned aggregate, tests were made on a series of mixes with from 3 to 9 sacks of cement per cu yd. Properties reported include compressive, flexural, and bond strength; modulus of elasticity; diagonal tension; and thermal conductivity. Field control practices for lightweight structural concrete are briefly considered.

RE-PROPORTIONING OF CONCRETE MIXTURES FOR AIR ENTRAINMENT . . 54-34

H. J. GILKEY — Feb. 1958, pp. 633-646 (V. 54)

Following a summary of current knowledge of air entrainment, the problems of mixture re-proportioning are presented and illustrated with unit-block solid-volume diagrams. Range of mixtures, from rich to lean, is covered for a structural grade concrete of 3-in. slump and a nominal 4 percent of entrained air. Three specific approaches to the problem of re-proportioning are indicated and illustrated. Revised proportions of the three base mixtures, (rich, medium, and lean) are tabulated and graphed for each of the three techniques of adjustment employed. The objective is not only to cover visually and systematically the manipulatory aspects of air entrainment but also to refocus attention on the unit-block, solid-volume concept as a useful technique and clarifying approach to the better comparative understanding of concrete mixtures in general.

STUDY OF CONCRETE PIPE IN SERVICE 54-35

W. J. McCOY, R. J. SWEITZER, and M. E. FLENTJE — Feb. 1958, pp. 647-656 (V. 54)

Portions of concrete pipe were removed from five existing water lines and analyzed to determine the extent of any leaching of lime that might have occurred. The selected samples represented various types and ages of pipe as well as exposure to water possessing several degrees of aggressiveness.

The cementitious structure of all test specimens was sound and appeared to be well bonded to the aggregate. Except for a thin inside surface layer usually of the order of 0.03 in., none of the samples had experienced any significant leaching of lime.

ULTIMATE STRENGTH DESIGN OF RECTANGULAR CONCRETE MEMBERS SUBJECT TO UNSYMMETRICAL BENDING 54-36

TUNG AU — Feb. 1958, pp. 657-674 (V. 54)

The procedures of proportioning rectangular reinforced concrete sections subjected to unsymmetrical bending in two directions based on ultimate strength method are formulated and discussed. To simplify design computations, charts are provided for determining dimensions of the equivalent compressive stress block after dimensions of the section and the arrangement of the reinforcement are assumed. Thus, the stresses in the tensile steel can be checked to verify the validity of the assumed section. The charts can be conveniently applied to sections subject to unsymmetrical bending with or without compressive force.

COMPRESSIVE STRENGTH AND ULTRASONIC PULSE VELOCITY RELATIONSHIPS FOR CONCRETE IN COLUMNS 54-37

M. F. KAPLAN — Feb. 1958, pp. 675-688 (V. 54)

Reports an investigation to determine to what extent compressive strength and pulse velocity tests indicate the variability and compressive strength of concrete as it exists in a series of columns. Concrete cubes site-cured under the same atmospheric conditions as the concrete columns had a compressive strength averaging 10 percent lower than the strength of the concrete in the columns. Concrete cubes continuously cured under water averaged 23 percent higher strength than the concrete in the columns.

When the pulse velocity in the columns was measured, the corresponding compressive strength as obtained from the pulse velocity-strength relationship for the site cubes averaged 18 percent lower than the actual strength of the concrete in the columns. The compressive strength obtained from the relationship for cubes continuously cured under water averaged 29 percent lower than the actual strength. Pulse velocity values for the concrete in the columns gave a better indication of the variation in strength quality of the concrete than did compressive strength results on concrete cubes.

SPACING OF SPLICED BARS IN BEAMS 54-38

S. J. CHAMBERLIN — Feb. 1958, pp. 689-698 (V. 54)

Beams, 6 x 6 in. in cross section with a 32-in. span, contained a single, spliced #4 bar, or two #4 bars, spliced in the region of constant moment. Lengths of lap were 3, 6, and 12 in. and clear spacings between the lapped bars were 0, ½, and 1 in.

Lapped lengths of 12 in. developed yield point stress in both the single and double bars. Single-bar beams failed by splitting of the bottom cover. Side splitting occurred in all of the double-bar beams. High bond stresses were developed. Load-deflection curves and ultimate loads showed little difference in strength between adjacent and spaced splices.

EFFECTS OF REVIBRATING CONCRETE 54-39

C. A. VOLLICK — Mar. 1958, pp. 721-732 (V. 54)

Tests were made to determine the effect of revibration at intervals of 1 to 4 hr after placing on properties of hardened concrete. Results show effect of revibration on compressive strength of concretes designed with varying cement contents and different admixtures. Effect on bleeding and hardening time is also given.

CONCRETE FOR SEWAGE WORK . . . 54-40

E. C. WENGER — Mar. 1958, pp. 733-738 (V. 54)

Concrete for sewage works and the control of concrete corrosion therein is fully discussed. Characteristics and treatment of sewage are briefly reveiewed, along with the conditions of exposure of concrete in such construction. Quality of concrete, construction practices, and other steps necessary to minimize concrete corrosion are presented.

CREEP OF CONCRETE UNDER VARIABLE STRESS 54-41

A. D. ROSS — Mar. 1958, pp. 739-758 (V. 54)

Creep has important effects on the stresses and deflections of reinforced and prestressed structures. Concrete structures in use are subject to variable stress whereas most of the data on creep have been obtained under constant stress. It is therefore desirable to be able to compute creep under variable stress from the results under constant stress.

Three methods for doing this are discussed and experiments designed to test these methods are described. Each method has a certain advantage in particular circumstances depending on the character of the stress variation, the extent of creep data available, and the accuracy required.

ULTIMATE RESISTING MOMENT OF BEAMS WITH COMPRESSION REINFORCEMENT 54-42

EUGENE GUILLARD — Mar. 1958, pp. 759-766 (V. 54)

A change in basic assumptions is proposed for ultimate strength design of beams with compression reinforcement. It is shown that the present method is inconsistent for shallow beams and slabs with large percentages of compression steel. A revised form of Eq. (A3) in Section A606 of the ACI Building Code (ACI 318-56) is suggested which permits incorporation of the change in assumptions.

FIRST SLIP-FORMED APARTMENT BUILDING IN THE UNITED STATES 54-43

JOHN H. DOGGETT — Mar. 1958, pp. 767-772 (V. 54)

Upper eight stories of ten-story apartment building were slip formed in 115 hr of around-the-clock operations. Structural framing, building of the forms, and construction practices are described, citing advantages peculiar to the method.

ACI'S DECADE OF PROGRESS......54-44

WALTER H. PRICE — Apr. 1958, pp. 825-828 (V. 54)

Retiring President Price evaluates the Institute's success in achieving long-range goals with a look at developments of the past 10 years. Expansion of membership, increased size of the ACI Journal, and heightened technical committee activity are cited, along with progress toward completion of the new ACI headquarters building. Increased Institute activity has been accentuated on the local level through regional meetings and special activities of the technical director, and the Institute's first local chapter has been organized on a provisional basis.

STRENGTH OF CONCRETE UNDER COMBINED TENSILE AND COMPRESSIVE STRESS 54-45

DOUGLAS McHENRY and JOSEPH KARNI — Apr. 1958, pp. 829-840 (V. 54)

An experimental study of the strength of concrete under combined tensile and compressive stresses was undertaken by loading hollow concrete cylinders to failure. Circumferential tension was developed by internal hydrostatic pressure, and axial compression was produced by end loading in a conventional testing machine. Compressive and tensile strengths were both reduced in the presence of an orthogonal stress of opposite sense.

Tests results are presented in terms of principal stresses and of octahedral normal and shearing stresses. In neither case does a simple linear relationship between stresses define the failure conditions satisfactorily throughout the full range from simple tension to simple compression.

USE OF CONCRETE IN MARINE ENVIRONMENTS 54-46

C. M. WAKEMAN, E. V. DOCKWEILER, H. E. STOVER, and L. L. WHITENECK — Apr. 1958, pp. 841-856 (V. 54)

Results of service tests indicate use of properly engineered concrete in marine environments is feasible, economical, and presents no unusual problem to the engineer. Discussion of this paper centers around several theories for the deterioration of concrete in sea water and concludes with recommendations for correct procedures to be observed for marine concrete construction.

SOME PHYSICAL PROPERTIES OF CONCRETES AT HIGH TEMPERATURES 54-47

ROBERT PHILLEO — Apr. 1958, pp. 857-864 (V. 54)

Experimental techniques are described and data are presented on the thermal expansion, density, and dynamic modulus of elasticity of concrete in the range 75-1500 F. Such information is necessary to evaluate stresses due to nonuniform heating which could result from a building fire or jet aircraft blast. The results indicate that weight loss due to loss of water is substantially complete at 800 F. At higher temperatures changes in weight are determined by the chemical nature of the aggregates. The coefficient of expansion increases above 800 F since expansion is no longer inhibited by drying shrinkage. At 1400 F the modulus of elasticity is reduced to less than half its value at 75 F, the exact reduction depending on the extent to which hydration had progressed at the time of exposure.

FLEXURAL CRACKS IN REINFORCED CONCRETE BEAMS 54-48

MICHAEL CHI and ARTHUR F. KIRSTEIN — Apr. 1958, pp. 865-878 (V. 54)

A new concept is introduced into the problem of crack formation in reinforced concrete beams subjected to pure flexure, along with simplified semi-empirical equations for the determination of the average minimum spacing and the average width of cracks in the concrete. Historical background given leads to development of the analysis and the assumptions incorporated in it. To verify the analysis, crack data from 16 test specimens are presented and used to augment the data from previous investigations.

CREEP OF PLAIN AND REINFORCED CONCRETE 54-49

P. G. FLUCK and G. W. WASHA — Apr. 1958, pp. 879-896 (V. 54)

Authors have reviewed English literature on laboratory and field tests of creep of concrete. Rather than abstract each article, they present a general discussion of information regarding the creep behavior and the factors influencing such behavior of plain and reinforced concrete. A list of 121 references is provided; 25 of these are specifically cited in the paper, but all have been considered in its preparation. This summary of published test results is intended for the general reader and may serve as a starting point for those who wish to continue study of this subject.

SPECIFIC SURFACE OF AGGREGATES RELATED TO COMPRESSIVE AND FLEXURAL STRENGTH OF CONCRETE........54-50

B. G. SINGH — Apr. 1958, pp. 897-908 (V. 54)

Concrete strengths depends on both W/C and specific surface of aggregate. For constant mix proportions, increased specific surface causes decrease in amount of cement relative to surface of aggregate, leaving more voids around surface of aggregate particles. With other mix proportions held constant, as specific surface increased both compressive strength and modulus of rupture tested lower at any given W/C. When compressive strength is plotted against O_c, a factor based on W/C, specific surface of aggregate, and aggregate-cement ratio, a single curve is obtained. A similar factor O_r is developed for flexural strength. A further adjustment is required, in part related to the greater absorption of water in the leaner mixes.

TENTATIVE RECOMMENDATIONS FOR THIN-SECTION REINFORCED PRECAST CONCRETE CONSTRUCTION.......54-51

COMMITTEE 324 — May 1958, pp. 921-928 (V. 54)

Intended as a supplement to ACI 318-56, this report highlights design and construction practices peculiar to thin-section reinforced concrete elements. High-early-strength concrete or accelerated curing is advised. Special grading limits for coarse aggregate are suggested, and specifications for steel and admixtures are noted. Concrete of 3750 psi strength is recommended for protected locations not in contact with the ground; 5000-psi concrete is recommended for other locations. Limits for air content, W/C ratio, and cement content are proposed. Report suggests allowable design stresses, and emphasizes accurate placing of and sufficient cover for reinforcement.

Fabrication is covered in provisions on mixing, molds, casting, curing, surface treatment, and tolerances of individual elements. Supervision and inspection during fabrication are stressed, with some suggested standards of acceptance. Method and sequence of erection are also treated, including connection devices, assembly tolerances, and waterproofing of joints.

HIGH STRENGTH STEEL AND CONCRETE RESULT IN MINIMUM COLUMN SIZES 54-52

FRANK W. CHAPPELL — May 1958, pp. 929-938 (V. 54)

Architectural design of 265 ft high building imposed severe structural restrictions which were met by using a lightweight structural concrete frame, concrete strengths as high as 6000 psi, and alloy steel bars with yield point of 82,365 psi in columns of lower stories. The saving in dead load combined with unusually high strengths of concrete and steel permitted the architect's clearances to be maintained. Unusual structural design features are described as well as precast concrete grills which break up the direct rays of the sun against considerable areas of windows and walls.

WARPING OF REINFORCED CONCRETE DUE TO SHRINKAGE 54-53

ALFRED L. MILLER — May 1958, pp. 939-950 (V. 54)

Objectionable deflections and deformations of structural elements, especially relatively thin slabs and shallow beams of buildings, usually are ascribed to faulty workmanship or materials, creep, and plastic flow when in fact they are evidence of warping. Warping due to temperature and moisture differentials is generally recognized but the effect of shrinkage has been relegated to the realm of uncertainty by attributing it to creep or plastic flow.

Experimental investigation reveals that warping of reinforced concrete members due to shrinkage during the period of seasoning is an inherent characteristic of reinforced concrete that can be anticipated and controlled. A realistic theory is developed by which the amount of warping can be predicted and provision made for its reduction or elimination.

TRANSVERSE STRENGTH OF CONCRETE BLOCK WALLS........54-54

F. W. COX and J. L. ENNENGA — May 1958, pp. 951-960 (V. 54)

Twelve concrete block wall panels were tested in pure horizontal flexure. The panels represented both 8-in. hollow load-bearing block and cavity construction with 4 in. thick wythes and 2-in. cavity. Joint reinforcement was used in half the panels. All results are expressed in terms of the maximum bending moment per foot of height which the wall withstood before breaking. The strength in horizontal span was found to be several times greater than the strength reported by other experimenters for vertical spans.

REINFORCEMENT OF PRESS FOUNDATIONS BY POST-TENSIONING 54-55

FRITZ KRAMRISCH — May 1958, pp. 961-964 (V. 54)

Existing foundations were post-tensioned to accommoderate new presses almost twice as heavy as those for which foundations were originally designed. Method is described and load analysis given.

HIGH-DENSITY CONCRETE FOR SHIELDING ATOMIC ENERGY PLANTS 54-56

HAROLD S. DAVIS — May 1958, pp. 965-978 (V. 54)

Concrete properties required for gamma ray absorption and neutron attenuation are outlined. "Fixed" water content and its role in slowing down fast neutrons are explained. Grouts and mortars, heavy aggregate properties, and use of boron are also covered. Placement methods evaluated include: conventional, pumping, prepacking, and puddling. Formwork problems including dimensional tolerances are outlined, and shields made of high-density concrete block are described. Tabulated data cover costs of materials as well as finished shielding structures.

TESTS OF FULL-SIZED PRESTRESSED CONCRETE BRIDGE BEAMS........54-57

INGE LYSE — May 1958, pp. 979-986 (V. 54)

Two full-sized prestressed concrete beams, identical with those made for Mandal Bridge in Norway, were tested to failure. The elastic and plastic deformations of the concrete due to prestressing and the shrinkage due to the drying of the concrete were observed. The load at first cracking agreed well with the computed value, and the strains measured in the beams agreed fairly well with the computed stresses. The load at failure corresponded with the load computed on the basis of the so-called simplified theory.

CONCEPT OF ELASTIC PARAMETERS.54-58

VALERIAN LEONTOVICH — May 1958, pp. 987-1008 (V. 54)

The concept of elastic parameters, defining mathematical relations between elastic properties of the member and its elastic parameters, is presented. It is further shown that integration of the concept into the elastic-center method substantially shortens and simplifies analysis of frames and arches of variable cross section. So that the concept and its application may be fully appreciated, a number of examples are presented.

LONG-TIME STUDY OF CEMENT PERFORMANCE IN CONCRETE. CHAPTER 11 — REPORT ON THE CONDITION OF THREE TEST PAVEMENTS AFTER 15 YEARS OF SERVICE......54-59

FRANK H. JACKSON—June 1958, pp. 1017-1032 (V. 54)

Discusses the present condition of three test pavements about 15 years old. One pavement is in western New York in a region subject to severe natural weathering, one in central Missouri where exposure conditions are moderately severe, and one in western South Carolina where mild weather prevails. Twenty-seven cements, differing widely in their chemical and physical properties, were used in these pavements.

After 15 years service the New York pavement exhibits surface scaling in varying amounts on almost all sections containing the non-air-entraining cements. However, except for the Type IV and Type V cements, there is no indication that any one non-air-entraining cement or type of non-air-entraining cement is more resistant to scaling than another. Type IV and Type V cements show greater average resistance to scaling than the other non-air-entraining types. All sections containing air-entraining cements are still completely free from surface scale.

Aside from some light scale or surface wear on the South Carolina project and some D-cracking on the Missouri road, neither of which can be associated in any way with a particular cement or cement type, all of the cements have performed equally well on both projects. Under the conditions prevailing on these projects variations in the chemical composition and fineness of the cement, within the limits represented by this study, appear to be without significance insofar as resistance to freezing and thawing is concerned.

(See also 44-21, 44-26, 44-33, 44-38, 46-17, 47-51, 49-52, 52-13, and 54-27)

STATIC AND FATIGUE STRENGTH IN SHEAR OF BEAMS WITH TENSILE REINFORCEMENT 54-60

TIEN S. CHANG and CLYDE E. KESLER — June 1958, pp. 1033-1058 (V. 54)

Dimensional analysis is employed in deriving expressions for the initial diagonal cracking load and the ultimate strength in shear of simply supported concrete beams with tensile reinforcement only. These expressions, which include size effect, are converted into nomographs for ease of application. This study of static strength includes results from tests of 105 beams, 42 of which were tested by the authors.

Fatigue tests were made on 39 reinforced concrete beams with tension reinforcement only. These beams were simply supported on a span of 60 in. and loaded at the third points. Statistical studies of the fatigue behavior with regard to initial diagonal cracking and final failure are included.

UNIFORM STRUCTURAL LIGHTWEIGHT AGGREGATE CONCRETE THROUGH CAREFUL PROPORTIONING AND CONTROL 54-61

PAUL J. FLUSS — June 1958, pp. 1059-1062 (V. 54)

Variations in bulk specific gravity of the aggregate and construction requirements make it necessary to give special attention to the careful proportioning, proper control, and adjustment of structural lightweight aggregate concrete. Experience on the Ferry Building, San Francisco, is cited.

EFFECT OF MIXING AND CURING TEMPERATURE ON CONCRETE STRENGTH 54-62

PAUL KLIEGER — June 1958, pp. 1063-1082 (V. 54)

Comprehensive study was made of compressive and flexural strength produced by different types of portland cement used in concretes mixed, placed, and cured at various temperatures between 25 F and 120 F. Tests indicate that there is a temperature during the early life of concrete which is considered optimum with regard to strength at later ages.

Effect of calcium chloride on strength at varying temperatures of mixing, placing, and curing is reported. Effect of cement temperature was found unimportant, except as it affected concrete temperature after mixing. More air-entraining agent was required for given air content as concrete temperature increased and slump decreased.

PRECAST REINFORCED CONCRETE SLAB BRIDGES WITH STIFFENED EDGES..54-63

ANDREW GALLIA — June 1958, pp. 1083-1092 (V. 54)

A method is given for the design of a simply supported highway bridge constructed of solid precast reinforced concrete slab units and two curb units. It is shown that this design improves the transverse wheel load distribution and an economical and practical bridge is achieved.

Paper is divided into (a) a discussion of the variables affecting the transverse distribution of wheel loads, such as transverse stiffness factor, edge stiffness factor, and effective stiffness factor; (b) a design procedure investigating the effects of the longitudinal and transverse live load moments in the slab; and (c) numerical examples showing economy of the proposed structure.

PROPORTIONING CONCRETE MIXTURES USING FLY ASH 54-64

C. E. LOVEWELL and GEORGE W. WASHA — June 1958, pp. 1093-1102 (V. 54)

Results of compressive strength tests of concrete are shown comparing concrete mixtures containing Chicago fly ash. The straight portland cement mixes contained from 4 to 6 bags of portland cement per cu yd of concrete and varied in half-bag increments. The mixes containing fly ash were proportioned to have approximately the same early strengths as the comparable straight portland cement mixes. To accomplish this the cement content could not be reduced by more than 1 bag per cu yd of concrete, and the fly ash added had to exceed the amount of cement removed. The amount of fly ash needed to replace each pound of cement removed increased as the richness of the original straight portland cement mix decreased. Data show that existing concrete technology can serve as a guide in proportioning concrete mixtures containing fly ash and that results can be predicted with reasonable accuracy.

MILITARY PERSONNEL RECORDS CENTER BUILT WITHOUT EXPANSION JOINTS 54-65

EARL B. COHN and W. A. WALL — June 1958, pp. 1103-1110 (V. 54)

One of the 20 largest buildings in the world is the Military Personnel Records Center in St. Louis, Mo. Construction of the main building (728 x 282 ft) without expansion joints is a significant design feature, and the case for omission of expansion joints is discussed in some detail. Cracking of floor slabs and building movement subsequent to construction are discussed.

This structure has demonstrated the feasibility of building large reinforced concrete structures without expansion joints; safety and satisfactory performance are possible if the structure is designed and construction controlled in conformity with recognized engineering principles.

CREEP AND CREEP RECOVERY OF CONCRETE UNDER HIGH COMPRESSIVE STRESS 54-66

A. M. FREUDENTHAL and FREDERIC ROLL — June 1958, pp. 1111-1142 (V. 54)

Four series of tests studied creep and creep-recovery of concrete under sustained compressive stresses varying between approximately 15 and 65 percent of the 28-day compressive strength. Test specimens, loaded at 28 days, were cylinders 10 in. high, 3 and 4 in. in diameter, made with four different mixes. The creep tests were conducted under conditions of controlled temperature and humidity. Shrinkage of unloaded control specimens in the same environment was recorded so that the actual creep curves (total time-dependent deformation minus shrinkage) could be obtained.

Supplementary compression tests were conducted to determine the effect of sustained load on strength and modulus of elasticity of the concrete.

To reproduce and represent the observed creep and creep-recovery curves, a mechanical model was introduced consisting of four elements, each representing a specific type of contribution to total creep. Model constants were evaluated and their variation with respect to mix and applied stress determined.

Using creep equations derived from the model, creep was predicted for four stress levels of each mix of Series IV. The equations were also used for evaluating stress relaxation from various stress levels.

Proceedings V. 55

TEST PROCEDURE TO DETERMINE RELATIVE BOND VALUE OF REINFORCING BARS (ACI 208-58) 55-1

COMMITTEE 208 — July 1958, pp. 1-16 (V. 55)

Supersedes 41-13 and 54-6

This test procedure provides a uniform basis for comparison of bond qualities of different reinforcing bars. The recommended test method uses companion beam type specimens, cast horizontally in inverted and normal positions so that the effects of water gain and settlement of concrete are included in the evaluation. The concrete surrounding the bars is in tension as bars are ordinarily used, which makes the results more acceptable to some users. Minimum criteria for acceptance are not included since the purpose is merely to establish relative bond values for the different bars under consideration.

The test may be used to evaluate the effectiveness of deformed bars having characteristics other than those described in "Tentative Specifications for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement," ASTM A 305-56T. For construction under the ACI Building Code, and evaluation of such bars is necessary since the code definition for a deformed bar is one which meets the requirements of ASTMA 305. Manufacturers of bars meeting the requirements of ASTM A 305 may use the test procedure for product improvement and to evaluate modifications in the design of deformations.

RECOMMENDED PRACTICE FOR DESIGN OF CONCRETE PAVEMENTS (ACI 325-58).........55-2

COMMITTEE 325 — July 1958, pp. 17-52 (V. 55)

Supersedes 53-39

Recommendations are presented for the design of rigid concrete pavements and bases based on practice proved successful in the United States. It offers comprehensive directions to design rigid airport and highway pavements or bases for conditions of climate,

traffic, available construction materials and equipment, and construction methods of the United States. It includes recommendations for soil foundations, selection of slab dimensions, joints, and details, for reinforced or nonreinforced pavement. Recommendations for design of cement-stabilized bases, continuously reinforced pavement, prestressed pavement, and rigid resurfacings are not included since their use has not yet developed a generally applicable practice. Design practices of all principal state and federal agencies concerned with paving have been reviewed and related within the limits recommended.

SPECIFICATIONS FOR CONCRETE PAVEMENTS AND CONCRETE BASES (ACI 617-58) 55-3

COMMITTEE 617 — July 1958, pp. 53-82 (V. 55)

Supersedes 47-49 and 53-52

Specifications apply to construction of portland cement concrete pavements and bases under normal conditions for both highways and airports. Standards and specifications of several other organizations are incorporated by reference.

Sources and acceptance standards for materials are given, as well as materials testing procedures and procedures for test of concrete strength to be used as a basis for proportioning of mixtures. Specifications for the materials and construction of soil foundations for concrete pavements and concrete bases are included. Provision is made for use of foundations stabilized by a cementing agent, but materials and construction of such are beyond scope of this specification.

Materials, dimensions, setting, and removal of forms are treated. Construction methods are specified for forming joints, installation of joint seal and load transfer devices, and placing of reinforcement. Concrete proportioning based on design for minimum strength is covered in detail; proportioning based on fixed cement content is allowed.

Other sections cover production of high-early-strength concrete and the handling and mixing of materials. Detailed requirements are given for placing, finishing, and curing of pavement concrete. Check of thickness of finished pavement is cited as basis for adjustments in payment to contractor. Protection of finished pavement, opening it to traffic and public use of thoroughfare during construction are also specified.

MINIMUM STANDARD REQUIREMENTS FOR PRECAST CONCRETE FLOOR AND ROOF UNITS (ACI 711-58) 55-4

COMMITTEE 711 — July 1958, pp. 83-94 (V. 55)

Supersedes 50-1 and 54-24

Minimum standard requirements for single units or multiple element assemblies, to be used in conjunction with ACI 318-56. Covers materials, design principles, manufacture including curing and handling, testing of completed units, installation plans, and special provisions for holes and openings in members. Design chapter treats such problems as dimensions, allowable deflection, structural concrete topping, reinforcement anchorage and location, and use of lightweight concrete.

ORIGIN, EVOLUTION, AND EFFECTS OF THE AIR VOID SYSTEM IN CONCRETE. PART I — ENTRAINED AIR IN UNHARDENED CONCRETE....55-5

See also Title No. 55-16, 55-22, and 55-33

RICHARD C. MIELENZ, VLADIMIR E. WOLKODOFF, JAMES E. BACKSTROM, and HARRY L. FLACK — July 1958, pp. 95-122 (V. 55)

Air in concrete originates in four general ways, producing "entrapped" and "entrained" voids which are differentiated by their spatial and pressure relationships to the surrounding water and solids. The action of air-entraining agents in modifying the void system in concrete is discussed. Once formed, the air void system deteriorates in characteristic ways, mainly by interchange of air between small bubbles and large, and by loss of a portion of the air during compaction of the concrete. Several factors determine the rate and extent of deterioration effected before hardening of the concrete are described.

The action of the air void system in improving workability and decreasing segregation and bleeding is discussed.

LOAD TEST ON FLAT SLAB FLOOR WITH EMBEDDED STEEL GRILLAGE CAPS...55-6

DONALD D. MEISEL, CYRIL D. JENSEN, and WALTER H. WHEELER — July 1958, pp. 123-132 (V. 55)

Steel grillage caps embedded in concrete flat slab and attached to steel columns were used in the addition to Smith, Kline, and French Laboratories. Because this was the first appearance of such a design in Philadelphia, a full scale load test was performed on the second floor of the new addition.

Since the second floor was designed for movable load of 300 psf, the static test load was doubled to 600 psf. Bags of rock salt (1,500,000 lb total) were spread over 2500 sq ft, and shifted to alternate locations. Stresses were determined by use of SR-4 strain gages fastened to the reinforcing steel and concrete, and dial micrometers installed at critical points under the slab measured deflections.

HEAVY MEDIA PROCESSING OF GRAVELS IN NEW BRUNSWICK 55-7

I. D. MacKENZIE — July 1958, pp. 133-138 (V. 55)

Materials of low specific gravity had to be removed from available local aggregate for the Beechwood development of the New Brunswick Electric Power Commission in order to produce concrete with satisfactory resistance to freezing and thawing. Heavy media separation plant used suspension of ferrosilicon and magnetite in water, removing aggregates which floated in the medium whose specific gravity was about 2.6. Aggregates which sank were cleaned and retained for concreting. Salvage and reuse of the suspension medium are explained.

LOAD TEST OF 120-FT PRECAST, PRESTRESSED BRIDGE GIRDER 55-8

FAZLUR R. KHAN and ANDREW J. BROWN — July 1958, pp. 139-150 (V. 55)

General design data are given for four prestressed concrete highway bridges and two prestressed concrete railroad bridges, built at the U. S. Air Force Academy site. One full size 120-ft. girder was tested in two stages, leading to final destruction, to check workmanship and validity of design assumptions. First the girder alone was loaded to cracking. Then a 9 ft wide and 7 in. thick slab was cast to form a composite unit which was loaded to failure. Results of both tests are discussed in detail.

CURING CONCRETE 55-9

COMMITTEE 612 — Aug. 1958, pp. 161-172 (V. 55)

Five fundamental requirements for proper curing of concrete discussed in some detail are: (1) preservation of adequate water content in concrete; (2) maintenance of concrete at some fairly constant temperature above freezing; (3) preservation of reasonably uniform temperature throughout the whole body of concrete; (4) protection from damaging mechanical disturbances; and (5) passage of sufficient time for hydration of cement and hardening of concrete. Specific initial and final curing procedures and materials are recommended for horizontal structures, vertical structures, mass concrete, and precast units.

PRESSURES ON FORMWORK.......55-10

COMMITTEE 622 — Aug. 1958, pp. 173-190 (V. 55)

This report is a preliminary step in the preparation of a recommended practice for design and construction of concrete formwork. It presents recommended design assumptions for lateral pressure of concrete on vertical formwork when revibration and external vibration are not to be used. It is intended to provide a safe guide within the range of most formwork and common construction conditions.

Part I was compiled from data first available, and on that basis certain recommendations were made.

Subsequently more data became available and are discussed in Part 2. From these further studies, modifications were derived in the conclusions.

FATIGUE OF CONCRETE — A REVIEW OF RESEARCH 55-11

GENE M. NORDBY — Aug. 1958, pp. 191-220 (V. 55)

Investigations of fatigue of concrete are reviewed starting in 1898 with the work of Considere and De Joly. More than 100 publications on the subject, including those in the foreign literature, were surveyed. The most important investigations are summarized and the salient facts which seem to be emerging from the research are listed. The work has been divided for discussion into six categories: fatigue in compression, fatigue in flexure, fatigue in tension, fatigue of bond, fatigue of reinforced concrete, and fatigue of prestressed concrete.

EFFECT OF RANGE OF STRESS ON FATIGUE STRENGTH OF PLAIN CONCRETE BEAMS 55-12

JOHN W. MURDOCK and CLYDE E. KESLER — Aug. 1958, pp. 221-232 (V. 55)

From the results of tests of 175 plain concrete beams subjected to repeated flexural loading, it was found that plain concrete exhibits no fatigue limit when subjected to loads which produce no reversals of stress. Fatigue strengths at 10 million repetitions of stress were determined for each of the several ranges of stress investigated, and these strengths were found to be dependent on the range of stress to which the specimens were subjected.

The test results are in good agreement with previous investigations insofar as valid comparisons may be made. The need for additional research is, however, most apparent, the results obtained from this investigation do not permit the definition of the fatigue behavior of plain concrete subjected to reversals of stress, nor do they permit a valid description of the process by which fatigue failures occur.

PROBABILITY OF FATIGUE FAILURE OF PLAIN CONCRETE. 55-13

JOHN T. McCALL — Aug. 1958, pp. 233-244 (V. 55)

Fatigue tests were run on concrete beams and the data were analyzed in an attempt to determine the relationship for concrete between stress S, number of cycles to failure N, and probability of failure P. It was found that this relationship can be expressed reasonably well graphically; one of the mathematical relationships investigated fitted the data at high stress levels fairly well, but the fit at the lowest stress level was poor. The extreme value functions investigated could not be used to describe the relationship.

FATIGUE BEHAVIOR OF REINFORCED CONCRETE BEAMS 55-14

TIEN S. CHANG and CLYDE E. KESLER — Aug. 1958, pp. 245-254 (V. 55)

This study concerns the fatigue behavior of small reinforced concrete beams, 4 x 6 x 64 in., designed to fail in flexure under static load. For this type of specimen, the results clearly indicate that the magnitude of repeated load determines the mode of failure. Briefly, a low magnitude repeated load generally will result in a flexural failure, fatigue of the steel, while a high magnitude repeated load will result in a shear failure.

FATIGUE PROPERTIES OF CONCRETE BEAMS 55-15

THOMAS E. STELSON and JOHN N. CERNICA — Aug. 1958, pp. 255-260 (V. 55)

Eleven concrete beams with regular tensile reinforcement were tested under repeated load applied 320 times per min. The beams were identical except for a slight increase in concrete strength during the period of testing. The ACI elastic-design load for the test beams was 2610 lb. The ultimate load was 8800 lb. The load causing fatigue failure in 500,000 cycles was 5720 lb. Thus, the ultimate load was 3.37 times the design load and the fatigue load was 2.18 times the design load.

ORIGIN, EVOLUTION, AND EFFECTS OF THE AIR VOID SYSTEM ON CONCRETE. PART 2—INFLUENCE OF TYPE AND AMOUNT OF AIR-ENTRAINING AGENT 55-16

See also Title No. 55-5, 55-22, and 55-33

JAMES E. BACKSTROM, RICHARD W. BURROWS, RICHARD C. MIELENZ, and VLADIMIR E. WOLKODOFF — Aug. 1958, pp. 261-272 (V. 55)

Air-entraining agents of differing chemical composition produce air voids of different size, distribution, and spacing. The amount of agent also has an effect on these parameters, on general, reducing the air void size and spacing when used in increasing amounts. Air entrained by an effective agent, in the amount recommended by ACI Committee 613, or greater, will usually provide a satisfactory air void system and satisfactory resistance of concrete to freezing and thawing. In general, the factors which tend to reduce spacing also tend to increase freezing-thawing resistance of concrete.

DESIGN OF SYMMETRICAL COLUMNS WITH SMALL ECCENTRICITIES IN ONE OR TWO DIRECTIONS. 55-17

FREDERICK P. WIESINGER — Aug. 1958, pp. 273-284 (V. 55)

A comprehensive and general method is presented for the design of columns according to the ACI Code, where e'/t is not more than ⅔ in either direction. Tables to speed up time-consuming trial and error computations for all standard cases and a simple method for the construction of straight-line charts are included.

PROPOSED RECOMMENDED PRACTICE FOR SELECTING PROPORTIONS FOR STRUCTURAL LIGHTWEIGHT CONCRETE 55-18

SUBCOMMITTEE ON PROPORTIONING LIGHTWEIGHT AGGREGATE CONCRETE, COMMITTEE 613 — Sept. 1958, pp. 305-314 (V. 55)

Superseded by ACI 613A-59

This subcommittee report is intended as a supplement to ACI Standard "Recommended Practice for Selecting Proportions for Concrete (ACI 613-54)" and describes a procedure for proportioning structural grade concrete containing lightweight aggregates. This procedure does not require the use of values for specific gravity or absorption of the aggregates but utilizes a "specific gravity factor." Use of this factor is illustrated and examples are included for proportioning both air-entrained and non-air-entrained mixes.

DESIGN OF CONCRETE OVERLAYS FOR PAVEMENTS 55-19

SUBCOMMITTEE VIII, COMMITTEE 325 — Sept. 1958, pp. 315-320 (V. 55)

Report traces the development of empirical formulas for structural capacity of two slabs, one superimposed on the other, and gives equations developed by Marcus and Palmer which permit determination of stresses in both the upper and lower slabs. Locating joints in the overlay above joints in the old slab is recommended. Design of reinforcement for the overlay is considered, as well as combining resurfacing with pavement widening. Also discussed are relative merits of a separation course between old and new slab, bonded resurfacing, and effect of subgrade condition.

STRENGTH OF CONCRETE UNDER COMBINED STRESSES 55-20

B. BRESLER and K. S. PISTER — Sept. 1958, pp. 321-346 (V. 55)

A criterion for failure of plain concrete subjected to combined stresses was established from tests of 65 tubular specimens tested to failure under various combinations of shearing and compressive stress. A procedure for determining the shearing strength of a special class of rectangular reinforced concrete beams

without web reinforcement was developed. Excellent correlation was obtained between calculated and observed shearing strength of a limited group of beams.

ECONOMIC FACTORS IN PRESTRESSED LIFT-SLAB CONSTRUCTION 55-21

EDWARD K. RICE — Sept. 1958, pp. 347-358 (V. 55)

The use of prestressed concrete lift slabs to obtain substantial advantage in performance of the slab is discussed. Items covered include cost trends in conventional versus lift-slab construction and factors affecting the economy of prestressed lift-slab construction including building layout, structural framing schemes, use of precast columns, connections, and prestressing layout.

ORIGIN, EVOLUTION, AND EFFECTS OF THE AIR VOID SYSTEM IN CONCRETE. PART 3—INFLUENCE OF WATER-CEMENT RATIO AND COMPACTION........55-22

See also Title No. 55-5, 55-16, and 55-33

JAMES E. BACKSTROM, RICHARD W. BURROWS, RICHARD C. MIELENZ, and VLADIMIR E. WOLKODOFF — Sept. 1958, pp. 359-376 (V. 55)

Size distribution, frequency of air voids, spacing factor, and freezing and thawing resistance of concrete are influenced by many factors, among the most significant being water-cement ratio and degree of compaction. Increased freezing and thawing resistance generally reflects a reduction in void size and spacing factor. Such reductions are obtained, other factors being equal, through reduced water-cement ratio, increased amount of air-entraining agent, and in the case of void size through increased periods of vibration. Reduction of water-cement ratio increases the proportion of air-entraining agent necessary to produce a given air content but the air content required for maximum durability is decreased as the water-cement ratio is decreased. Increasing periods of vibration reduce the total air content and increase the specific surface of air voids, but have relatively little effect on spacing factor. For any one concrete there is an optimum air content and void spacing factor for optimum resistance to freezing and thawing. Spacing factor which obtains at optimum freezing and thawing resistance of a single concrete variously vibrated may or may not be the smallest in magnitude.

STRESSES IN REINFORCED CONCRETE SECTIONS SUBJECT TO TRANSIENT TEMPERATURE GRADIENTS 55-23

HAROLD SAMELSON and ABBA TOR — Sept. 1958, pp. 377-386 (V. 55)

Authors investigated stresses in walls of underground reinforced concrete cylindrical tanks containing liquids whose temperature varied from 50 to 500 F as a function of time. Stresses were checked for both the straight line temperature gradient, which represents a steady state of heat flow through the tank wall, and for the transient gradient. The transient gradient may be defined by a family of curves, each of which represents the temperature gradient at a given time station. Only the results for sections sufficiently removed from the ends where perturbational effects can be ignored are treated here.

Generally temperature stresses in structures are evaluated on the basis of a straight line temperature gradient only. This assumption may be justified in problems dealing with one dimensional heat transfer through thin structural material of relatively high conductivity. However, for relatively thick sections of low conductivity the transient gradient will produce a more severe stress condition. This stress condition which involves the entire section in a smooth variation may last for a considerable period and is not to be neglected under the assumption of a high localized state of stress which is relieved as plastic yield occurs.

The outlined solution is limited to problems of one dimensional heat flow.

SHEAR STRENGTH OF LIGHTWEIGHT REINFORCED CONCRETE BEAMS....55-24

J. A. HANSON — Sept. 1958, pp. 387-404 (V. 55)

This report describes tests employed and the results obtained in a study of the resistance of lightweight structural quality concrete in diagonal tension. A comparison of the shear strengths of the various beams, studied on an equal compressive strength basis, showed somewhat better performance of the sand-and-gravel concrete. However, when the comparison was extended to include a range of shear strength data reported in the literature by other investigators, the particular lightweight aggregate concretes considered here were as strong in shear, on an average basis, as the normal weight concretes.

Most of the beams sustained an ultimate load higher than that which caused diagonal cracking, but analysis of test data showed that such excess strength was related to location of the diagonal tension crack. This location was, within limits, a matter of chance, and load capacity above diagonal cracking load was therefore not a dependable quantity. This conclusion is believed generally applicable to beams without web reinforcement in which true diagonal tension may cause or initiate failure.

Deflections of the lightweight concrete beams were 15 to 35 percent greater than those of normal weight beams of equal strength.

ACI HEADQUARTERS PRESENTED A CHALLENGE IN CONCRETE........55-25

MINORU YAMASAKI — Oct. 1958, pp. 419-426 (V. 55)

The architect for ACI's headquarters building recounts some of the considerations which influenced his selection of folded plate roof and other design elements. The potential of precasting for economically bringing new form and fine texture to concrete buildings is cited.

CANTILEVERED FOLDED PLATE ROOFS ACI HEADQUARTERS.......55-26

CHARLES S. WHITNEY — Oct. 1958, pp. 427-430 (V. 55)

The structural engineer reports on some of the problems he considered in designing the folded plate roof which cantilevers 20 ft from central corridor bearing walls at the ACI headquarters building. Illustration and brief comment show roof in relation to the total structural scheme.

CONSTRUCTION FOR ACI........55-27

JOHN STRANG — Oct. 1958, pp. 431-438 (V. 55)

The general contractor tells of precasting and erection of 46 folded plate sections which comprise the roof of the ACI headquarters building. Concrete mix data are given, and problems of establishing an architecturally satisfactory finish are cited. Cast-in-place fluting of the corridor walls is also discussed.

FOLDED PLATE DOME IDEAL FOR AUDITORIUM 55-28

LYNDON WELCH — Oct. 1958, pp. 441-446 (V. 55)

Design and construction of a folded plate roof over an auditorium at Wayne, Mich., are discussed. Dimensions, design loading, decentering procedure, and deflecton are described.

FOLDED SLAB CONSTRUCTION.....55-29

FELIX J. SAMUELY — Oct. 1958, pp. 447-460 (V. 55)

Author discusses design principles for folded slab roofs, stair landings, and galleries, with special attenton to shear forces and to stresses produced by differential deformation in the slabs. Beam action of the fold or "quoin" is explained. Precast elements, prestressing, and composite construction (precast with cast-in-place concrete) are shown as they apply to folded slab construction. Structures in England and America illustrate use of folded slabs in a wide variety of shapes.

R/C CORE MAIN STRUCTURAL ELEMENT IN 22-STORY OFFICE TOWER......55-30

OTTO SAFIR — Oct. 1958, pp. 461-468 (V. 55)

Because of its narrow width and the required resistance against wind forces and earthquakes, the main structural element of the tower is formed by the reinforced concrete core which houses the building services, i.e., elevators, staircases, and lavatories. This cellular core resists all horizontal forces and carries the greater part of the vertical loads.

The office section surrounding this core is a composite of structural steel and reinforced concrete to reduce the column sections to a minimum and to achieve rapid construction. The method of analysis of the core is described, as well as the construction procedure which resulted in the construction of one complete floor in 7 working days.

PRECAST CONCRETE GIRDERS REINFORCED WITH HIGH STRENGTH DEFORMED BARS......55-31

J. R. GASTON and EIVIND HOGNESTAD — Oct. 1958, pp. 469-484 (V. 55)

Two 0.38-scale model roof girders were tested to develop an unusual type of precast concrete building frame. The roof girder selected departs from customary practice primarily by its slender and graceful T cross section, by its high strength longitudinal tension reinforcement, and by its inclined stirrup reinforcement. Structural design was based on the ultimate strength design procedure given in the appendix of the 1956 ACI Building Code, with some departures justified by the model girder test results. Twenty 58-ft girders were later manufactured for two laboratory buildings.

SHEARING STRENGTH OF PRESTRESSED LIFT SLABS..........55-32

A. C. SCORDELIS, T. Y. LIN, and H. R. MAY — Oct. 1958, pp. 485-506 (V. 55)

A research investigation on the ultimate shearing strength of reinforced and prestressed concrete lift slabs included the testing of 15 slabs, 12 of which were prestressed with unbonded cables. All specimens were 6 ft square and had thicknesses of 6, 8, or 10 in. The slabs were supported along all four edges and centrally loaded.

Major variables were concrete strength, amount of prestressing or reinforcing steel, amount of initial prestress, size of steel collars, thickness of slab, and amount of collar recess.

A comparison of test results with expressions for ultimate shearing strength of reinforced concrete slabs proposed by Elstner and Hognestad and by Whitney indicate that these expressions, with proper interpretation, may also be used for the prestressed slabs included within this series of tests.

ORIGIN, EVOLUTION, AND EFFECTS OF THE AIR VOID SYSTEM IN CONCRETE. PART 4—THE AIR VOID SYSTEM IN JOB CONCRETE 55-33

See also Title No. 55-5, 55-16, and 55-22

RICHARD C. MIELENZ, VLADIMIR E. WOLKODOFF, JAMES E. BACKSTROM, and RICHARD W. BURROWS — Oct. 1958, pp. 507-518 (V. 55)

The air void system observed in concrete from engineering structures is comparable to that observed in concrete specimens prepared in the laboratory. The void system in non-air-entrained concrete varies widely, the observed specific surface ranging from 107 to 1111 in.$^{-1}$ In air entrained concrete, the observed specific surface ranges from 615 to 1600 in.$^{-1}$ and the spacing factor ranges from 0.0023 to 0.0081 in. The results of the examination indicate that a satisfactory air void system in job concrete is assured if the recommendations of ACI 613-54 are followed.

Methods for microscopical measurement of the air void system in hardened concrete are described in an appendix to Part 4.

PROPOSED ACI STANDARD: RECOMMENDED PRACTICE FOR HOT WEATHER CONCRETING 55-34

ACI COMMITTEES 605 — Nov. 1958, pp. 525-534 (V. 55)

Superseded by ACI 605-59

This recommended practice provides information useful in minimizing detrimental effects of hot weather on concrete. Means are described for reducing concrete temperature by proper attention to ingredients; methods of production and delivery; and care in placement, protection, and curing. Information is given on the use of admixtures to reduce mixing water requirements and to retard setting. Emphasis is given to the importance of meticulous attention to the use of standard procedures in testing concrete made in hot weather.

PROPOSED REVISION OF ACI STANDARD 614-42: RECOMMENDED PRACTICE FOR MEASURING, MIXING, AND PLACING CONCRETE 55-35

COMMITTEE 614 — Nov. 1958, pp. 535-566 (V. 55)

Superseded by ACI 614-59

An outline of practices which have generally been found desirable for first class results in measuring, mixing, and placing concrete. Although many of these recommendations are applicable and should be used in connection with special types of concrete, i.e., lightweight, prepacked, etc., it is conventional concrete to which they specifically apply. Presents a comparatively high standard of practice rather than common practices, therefore recommendations are made on a "should" basis leaving to the user the responsibility of putting them on a "shall" basis in specifications for his work to the extent he considers worthwhile.

LOAD FACTORS 55-36

EDUARDO TORROJA (International Council for Building Research) — Nov. 1958, pp. 567-572 (V. 55)

This committee studied the various sources of error in assumptions, design, workmanship, or evaluation of materials, and arrived at some recommendations in a very philosophical manner. The same ideas and numerical values were adopted by the European Committee on Concrete in Rome, April, 1957. The entire analysis is best read in the original report, but a few of the highlights are presented in this abstract.

MOMENT AND SHEAR REDISTRIBUTION IN TWO-SPAN CONTINUOUS REINFORCED CONCRETE BEAMS ...55-37

GEORGE C. ERNST — Nov. 1958, pp. 573-590 (V. 55)

Twenty-four two-span continuous beams were tested to determine the manner and degree of moment and shear redistribution after yielding of the first critical section. Support displacement conditions were selected to provide severe redistribution requirements.

Manner and degree of moment and shear redistribution were essentially the same for all beams, with redistribution beginning with the start of steel yield at the first critical section and becoming practically complete on initial yielding of the final critical section. Transverse ties designed to resist all the shear at plastic collapse provided adequate protection against diagonal tension failure with one exception.

Concentrated plastic rotation values indicate a sufficient capacity for the attainment of crushing moments at all critical sections for the steel ratios and support displacements of these tests. The amount available for redistribution may become limited by high steel ratios.

INFLUENCE OF WATER-CEMENT RATIO ON MORTAR IN WHICH SHRINKAGE IS RESTRAINED 55-38

F. A. BLAKEY — Nov. 1958, pp. 591-604 (V. 55)

Report on the stress and strain conditions at the instant of cracking for small bars of cement mortar whose shrinkage was restrained from an early age by a centrally placed steel rod. Dr. Blakey shows that crack-

ing probably starts as a definite elastic strain in the cement paste phase of the mortar. He also reports on the creep and shrinkage of mortars.

BEHAVIOR OF ONE-STORY REINFORCED CONCRETE SHEAR WALLS CONTAINING OPENINGS 55-39

JACK R. BENJAMIN and HARRY A. WILLIAMS — Nov. 1958, pp. 605-618 (V. 55)

A number of scale model one-story reinforced concrete shear walls containing openings were tested as a part of a major study of shear walls. This paper reports on the observed behavior, theoretical studies, and recommendations for analysis of such walls. Studies of the influence of variations in reinforcing are included.

LIGHTWEIGHT CONCRETE MADE WITH EXPANDED BLAST FURNACE SLAG..55-40

D. W. LEWIS — Nov. 1958, pp. 619-634 (V. 55)

The tests reported provide data on both insulating and structural concretes made with typical expanded slag aggregates. The test data provide information on strength, durability, heat transmission, and unit weight of concretes made with various cement contents and amounts of entrained air. The effects of different aggregate top sizes and of various natural sand substitutions for the fine aggregate are discussed.

EFFECT OF AXIAL COMPRESSION ON SHEAR STRENGTH OF REINFORCED CONCRETE FRAME MEMBERS......55-41

J. W. BALDWIN, JR. and I. M. VIEST — Nov. 1958, pp. 635-654 (V. 55)

An experimental investigation was conducted to determine the effect of axial compression on the shear strength of reinforced concrete members without web reinforcement. It involved tests of knee frames with ratios of axial force to shear varying from 0 to 6, and covered the entire range from failure caused by shear in the absence of axial load to failure caused by eccentric compression. The investigation was an extension of an earlier study involving specimens with the axial load equal to shear and specimens with no axial load, and was thus limited almost entirely to variations of the load ratio.

The observed diagonal tension cracking loads were found in good agreement with the results of the earlier study. On the other hand, the shear compression strength was found to increase with axial load considerably faster than indicated by the earlier tests. A modification of an empirical parameter in an existing theoretical expression for the ultimate strength was found necessary. This modification suggests that at shear compression failure the compatibility of strains, as well as the equilibrium of forces is a function of the axial load.

CONTINUOUS REINFORCEMENT IN HIGHWAY PAVEMENTS 55-42

SUBCOMMITTEE VII, COMMITTEE 325 — Dec. 1958, pp. 669-678 (V. 55)

A brief description of the continuously reinforced pavements which are now under observation and their performance, a statement of the present status of committee knowledge on the subject of continuous reinforcement, recommendations for future research, and a statement of future plans of the committee.

STRESS DISTRIBUTION AFFECTS ULTIMATE TENSILE STRENGTH.....55-43

JAMES S. BLACKMAN, GERALD M. SMITH, and LYLE E. YOUNG — Dec. 1958, pp. 679-684 (V. 55)

Specimens were subjected to combinations of axial, eccentric, and flexural loads to produce different patterns of stress distribution. The effect of stress distribution across the section has a significant effect on the ultimate tensile strength of concrete mortar specimens.

LIGHTWEIGHT CONCRETE DECK FOR TAPPAN ZEE BRIDGE MAIN SPANS..55-44

W. G. MULLENS — Dec. 1958, pp. 685-694 (V. 55)

Proportioning, testing, and field control are described in detail. The project demonstrated that high strength lightweight concrete may be produced using cement factors similar to those required for normal weight concrete through the use of drier consistencies with lowered total water content. Presaturation of aggregates and stabilization of free moisture content was the key to successful control. The contribution of natural sand content to compressive strength and workability is mentioned.

SHEAR, DIAGONAL TENSION, AND ANCHORAGE IN BEAMS...........55-45

E. M. RENSAA — Dec. 1958, pp. 695-716 (V. 55)

Problems relating to shearing strength and diagonal tensile strength of reinforced concrete beams are discussed. Particular attention is given to conditions at points of contraflexure. It is pointed out that bending stresses will have an influence on both the direction of tension cracks and on the shearing strength of beams. The effect of shrinkage stresses will also have considerable influence on the diagonal tensile strength. Actual direction of cracks may cause an increase in anchorage steel tension greater than that found by ordinary bending moment theory. It is shown that the ordinary formula for shearing stresses in reinforced beams is not applicable at sections where there are no bending stresses.

STRAINS IN BEAMS HAVING DIAGONAL CRACKS 55-46

D. WATSTEIN and R. G. MATHEY — Dec. 1958, pp. 717-718 (V. 55)

Several reinforced concrete beams were tested to determine the validity of the usual assumptions that longitudinal reinforcement does not transfer vertical shear across a diagonal tension crack and that the maximum compressive strain within the shear span is developed at the extreme fiber. Extension strain measurements in the steel and the concrete indicated that a plane section did not remain plane following development of a diagonal crack and that the maximum compressive strains in the concrete occurred some distance below the extreme fiber. The longitudinal reinforcement was found to carry considerable vertical shear across a crack, but this force decreased rapidly as the load approached the maximum.

INFLUENCE LINES FOR PRESSURE DISTRIBUTION UNDER A FINITE BEAM ON ELASTIC FOUNDATION.........55-47

K. C. RAY — Dec. 1958, pp. 729-740 (V. 55)

A set of influence lines is presented for pressure distribution under a finite beam on elastic foundation. Values of the dimensionless parameter have been selected to cover most of the practical cases. Experiment indicates that influence lines for a parameter of 0.0001 may be used for infinitely stiff footings.

CONCRETE SPACE STRUCTURES — RELATION BETWEEN FORM AND STRUCTURAL DESIGN 55-48

A. M. HAAS — Jan. 1959, pp. 749-758 (V. 55)

Concrete has brought to the architect and structural engineer new techniques of design with fresh possibilities of form and shape. By its use, enclosed space can take many shapes other than the rectangle to which low tensile materials such as natural stone had once limited it. The evolution and potential of these concrete space structures is briefly presented.

CRITERIA FOR MODERN SPECIFICATIONS AND CONTROL 55-49

EDWARD A. ABDUN-NUR and LEWIS H. TUTHILL — Jan. 1959, pp. 759-768 (V. 55)

A philosophy of specification writing is advocated which will take full advantage of engineering knowledge, modern equipment and methods, and the statistical control of the end product. To accomplish this,

"design criteria" for specifications, modeled after structural design procedures, are suggested.

An example of design criteria making use of "self-functioning" features, automation, contractor motivations, end-product provisions, use of reference specifications, uniformity requirements, investigation of local conditions and practices, use of statistical methods, use of labor reducing features, elimination of expressions such as "approval of the Engineer" which cannot be evaluated by the bidder, and in general, deciding what is needed and requiring it clearly, is given.

Realistic up-to-date specifications, trained and capable inspectors, and intelligent supervision by field engineers will result in maximum return for construction funds.

SETTING TIME OF CONCRETE CONTROLLED BY THE USE OF ADMIXTURES 55-50

RAYMOND J. SCHUTZ — Jan. 1959, pp. 769-782 (V. 55)

Terminology and definitions of setting time are discussed, factors influencing setting time are reviewed, and methods of controlling setting time are described. Examples of construction projects that have successfully utilized set control to improve concrete quality and solve special problems are given.

FLEXURAL BOND TESTS OF PRETENSIONED PRESTRESSED BEAMS 55-51

NORMAN W. HANSON and PAUL H. KAAR — Jan. 1959, pp. 783-802 (V. 55)

Presents an investigation of flexual bond in beams pretensioned with seven-wire strand of 1/4, 3/8, and 1/2 in. diameter. Primary object was to clarify the factors affecting bond action and strength, and to study the influence of certain variables on strand slip. This principal factor investigated was variation of strand embedment length.

The experimental results are discussed in detail, and criteria are presented for adequate design with respect to general bond slip of pretensioned strand. A hypothetical shape for the flexural bond stress wave immediately before bond slip is derived from the experimental results reported.

AGGREGATE GRADING AFFECTS AIR ENTRAINMENT 55-52

B. G. SINGH — Jan. 1959, pp. 803-810 (V. 55)

Both plain and air-entrained concretes were made with aggregate of constant specific surface whose grading was varied while other mix proportions were held constant. Mixes made with a given aggregate grading which entrained more air under natural conditions (no air-entraining agent) also entrained proportionately more air with an air-entraining admixture. Relative effect of the different size fractions of aggregate on air entrainment are evaluated, assigning the greatest weight to material passing the No. 25 and retained on the No. 52 sieve. Reduction in sand content or increasing its fineness both tend to decrease air entrainment potential.

PRESTRESSED PAVEMENT: A WORLD VIEW OF ITS STATUS 55-53

SUBCOMMITTEE VI, COMMITTEE 325 — Feb. 1959, pp. 829-838 (V. 55)

Reports on experiment and achievement in prestressed pavements throughout the world. Six factors selected for discussion include: design practices, choice of prestressing methods, types of aggregates and cements, methods of reducing subgrade friction, load tests and performance records, and cost comparison with conventional pavement.

TREMIE CONCRETE CONTROLLED WITH ADMIXTURES 55-54

J. WAYMAN WILLIAMS, JR. — Feb. 1959, pp. 839-850 (V. 55)

Noting that nonuniform quality and excessive laitance and disadvantages usually associated with tremie concrete, author reports on laboratory tests and field applications which show that retardation and air entrainment will reduce laitance and improve the flow, the uniformity, and the pattern of heat development in tremie concrete.

EFFECTS OF LONGITUDINAL FORCES ON PORTAL FRAME SUPPORTING A HIGHWAY BRIDGE DECK 55-55

TUNG AU and THOMAS D. Y. FOK — Feb. 1959, pp. 851-866 (V. 55)

Longitudinal forces resulting from live load on a highway bridge deck and from bearing friction at supports of bridge girders produce shear, bending, and torsion in the supporting pier. Authors analyze a type of pier often used in highway bridges, namely the portal frame fixed at supports, subject to such forces.

Loading is assumed unsymmetrical with respect to the center line of the portal frame. Analysis by moment distribution is extended to include the effects of torsion. The advantages and limitations of the method of analysis are discussed, and the solution for frames with prismatic members is formulated.

EXPANSION AND CRACKING STUDIED IN RELATION TO AGGREGATE AND THE MAGNESIA AND ALKALI CONTENT OF CEMENT 55-56

W. C. HANSEN — Feb. 1959, pp. 867-878 (V. 55)

Aggregates from Alabama, Illinois, and Kansas were studied in concretes made with cements having 0.23 to 1.4 percent alkali and 2.1 to 4.9 percent MgO. Studies extended over a period of 105 months. It is concluded that some of the expansion and cracking of concrete made with some sand-gravel aggregates from Kansas may be caused by a combination of alkali-aggregate reaction plus the hydration of periclase. The alkali-aggregate reaction is believed responsible for starting a mechanism which permits the periclase to cause excessive expansion. The periclase content of the cement does not appear to influence cracking obtained with the Alabama aggregate.

WEAR-RESISTANT CONCRETE CONSTRUCTION 55-57

SHU-T'IEN LI — Feb. 1959, pp. 879-892 (V. 55)

Presents requirements for materials, methods, and workmanship in constructing for resurfacing floors, platforms, and aprons subject to heavy traffic or to severe use from the handling of heavy materials. Various methods of treating wearing surfaces made of concrete are discussed.

SPECIFIC SURFACE OF AGGREGATES APPLIED TO MIX PROPORTIONING . . 55-58

B. G. SINGH — Feb. 1959, pp. 893-902 (V. 55)

Suggested proportioning method, applicable to both continuous and gap-graded aggregates, uses specific surface of aggregate as an index of grading. Two charts are offered for use with this method. After selecting the W/C ratio to give a required strength, the first chart is used to choose an aggregate-cement ratio that will give desired consistency at the selected W/C. From the second chart a specific surface corresponding to the aggregate-cement ratio is chosen to allow for slightly higher or lower sand content. The fine and coarse aggregate are combined (as illustrated) to give the required specific surface. Charts are for irregular, 3/4 in. maximum size aggregate, but charts for proportioning with other types and sizes of aggregate may be similarly developed.

COMMENTARY ON CONCRETE 55-59

ROBERT F. LEGGET — Mar. 1959, pp. 925 934 (V. 55)

Milestones of technology as reviewed at the dedication of the ACI Headquarters Building.

BLAST RESISTANCE OF REINFORCED CONCRETE BEAMS INFLUENCED BY GRADE OF STEEL 55-60

WARREN A. SHAW and J. R. ALLGOOD — Mar. 1959, pp. 935-946 (V. 55)

Method for determining the influence of grade of reinforcing steel on blast resistance of beams is based

on preselected criteria of failure. The peak dynamic load capacity is calculated for beams of a given configuration but having different percentages and grades for reinforcing steel. These calculations are made for blast-type loads of different duration. Plots of the results indicate that suitability of various steel grades will depend primarily on maximum permissible deflection, characteristics of the loading, and amount of tension steel used.

CONTROL OF CONCRETE MIXES....55-61

EDWARD A. ABDUN-NUR and JOSEPH J. WADDELL —Mar. 1959, pp. 947-962 (V. 55)

Concrete control procedures for the Northern Illinois Toll Highway resulted in greater contractor efficiency, lower costs, and closer conformance to specification requirements than usually obtained on similar work. Supervision of the numerous contracts was effected by the section engineers, general consultant, and testing laboratories working in unison to insure quality of materials and uniformity of structural and pavement concrete.

Semiautomatic batching and central mixing plants, which were equipped with automatic recording moisture meters, finish screens for coarse aggregate, and recorders to indicate batch weights, significantly contributed to the good control of concrete quality.

ROLE OF CEMENT IN THE CREEP OF MORTAR 55-62

A. M. NEVILLE — Mar. 1959, pp. 963-984 (V. 55)

Creep of mortar specimens made with 15 different portland cements and subjected to a sustained compressive stress was measured over a period of several months. These tests, involved as many as 700 specimens, indicate that creep is approximately proportional to the ratio of applied stress to strength of mortar at the time of load application, regardless of the identity of the cement. The relationship between creep and the stress-strength ratio appears to hold good for both dry and humid storage conditions, provided specimens are free from shrinkage. A wide range of stresses has been investigated and, for the mix proportions used, the stress-strength ratio seems to be the most important factor influencing the magnitude of creep. Cement fineness was not found to affect creep in the range tested.

Paper reviews in some detail factors influencing strength of cement, and also discusses the creep data of other investigators in relation to the proposed creep versus stress-strength ratios relationship.

DESIGN AND CONSTRUCTION OF A MODERN PARKING GARAGE......55-63

WALTER E. RILEY — Mar. 1959, pp. 985-994 (V. 55)

Haunched flat slab construction with round columns was used for a six level parking garage built in Phoenix, Ariz. Approximately 137 x 200 ft, garage has ramps at a 12 percent grade. Traffic design, structural features, construction practices, and shrinkage cracking are discussed. Camber was introduced into slabs by jacking the forms while they held the finished but unhardened concrete.

DYNAMICS AND STATICS IN CONCRETE INDUSTRY PROGRESS 55-64

DOUGLAS McHENRY—Apr. 1959, pp. 1069-1074 (V. 55)

Retiring president of ACI, discusses the concrete industry with respect to other fields of scientific endeavor and its own history and future.

RUSSIAN PROGRESS IN CONCRETE TECHNOLOGY 55-65

JAMES D. PIPER and WALTER H. PRICE — Apr. 1959, pp. 1075-1088 (V. 55)

In May 1958 the authors inspected concrete construction in Moscow and Leningrad where they visited laboratories, design office, precasting plants, housing developments, and bridge and plant construction. They report that precast concrete is being used almost exclusively for building construction in these cities, where 86,000 apartments, mostly in five-story buildings, are planned for 1959. Prestressed concrete is used wherever possible in the Soviet Union and the Russians are engaged in large-scale research and development of concrete materials and construction.

SHEAR STRENGTH OF TWO-SPAN CONTINUOUS REINFORCED CONCRETE BEAMS 55-66

JOSE J. RODRIGUEZ, ALBERT C. BIANCHINI, IVAN M. VIEST, and CLYDE E. KESLER — Apr. 1959, pp. 1089-1130 (V. 55)

Fifty-two continuous reinforced concrete beams were tested under concentrated loads and the results analzed in an effort to determine the following: (1) effect of continuity on the shear strength of statically indeterminate members, (2) contribution of web reinforcement to shear strength, and (3) to establish the minimum amount of web reinforcement required to prevent shear failures. The following variables were included: type of loading, length of negative moment longitudinal reinforcement, percentage of web reinforcement, and grade of longitudinal reinforcement.

Fifteen beams were designed with no web reinforcement, 13 beams had the amount of web reinforcement required by the 1951 ACI Code, and 24 beams were designed with more web reinforcement than required by the ACI Code.

An analysis of the test results indicated good agreement with the calculated values for the loads at diagonal tension cracking, shear compression failure, and flexural failure, as computed with the aid of existing mathematical expressions developed from tests of simple and restrained beams. When the amount of web reinforcement was determined by equating the formulas for maximum flexural and maximum shear loads, it was found to be more than was necessary.

SLIP-FORM DETAILS AND TECHNIQUES 55-67

J. F. CAMELLERIE — Apr. 1959, pp. 1131-1140 (V. 55)

A cursory description of the slip-form construction process — its advantages and limitations. Suggests practical considerations for good results: how to maintain a uniform supply of concrete and a uniform rate of placement, how to keep the construction deck level and walls in vertical alignment, techniques of placing the concrete, and problems of detailing and placing the steel. Surface finishes are also covered, and precautions for winter concreting indicated.

HIGH-DENSITY CONCRETE MADE WITH HYDROUS-IRON AGGREGATES 55-68

HAROLD S. DAVIS and ORVILLE E. BORGE — Apr. 1959, pp. 1141-1148 (V. 55)

Data are presented on the physical properties of a high-density concrete tested under standard conditions and after heating at temperatures of 85, 200, and 350 C. The concrete has a density of 218 lb per cu ft and a fixed water content of about 4.3 percent at 85 C, which makes it a desirable material for biological shields around atomic power reactors. Computed values of attentuation lengths are included for fast neutrons and gamma radiation.

QUALIFICATION PLAN FOR READY-MIXED CONCRETE PLANTS 55-69

C. E. PROUDLEY — May 1959, pp. 1165-1172 (V. 55)

The North Carolina State Highway Commission lists ready-mixed concrete plants approved as sources of concrete for state highway work on the basis of periodic checks by its engineers and inspectors. Ratings of plants on the approved list are based on plant equipment and layout and on qualifications of the plant employees. An inspection classification further indicates whether there is need for close scrutiny by the consumer, or if the plant may be trusted to apply conscientious control of quality and uniformity. Materials used by the approved plants are inspected and tested by highway commission facilities, and a training program qualifies plant employees as concrete technicians.

FATIGUE STUDY OF AIR-ENTRAINED CONCRETE 55-70

JOHN de C. ANTRIM and JOHN F. McLAUGHLIN — May 1959, pp. 1173-1182 (V. 55)

Fatigue tests were performed on two types of concrete each proportioned for the same 28-day compressive strength; one contained only "accidental" air, while the other contained intentionally entrained air which was maintained at a constant level. There was little variation in the ages of the specimens which were tested at stress levels of 50, 60, 70, 80, and 90 percent of the ultimate static compressive strength of the respective mixes. Within the limits of the investigation, the fatigue behavior of air-entrained plain concrete is similar to that of non-air-entrained plain concrete. However, the air-entrained concrete was more uniform than the non-air-entrained concrete with regard to both fatigue and static strength properties.

CYLINDRICAL SHELL ANALYSIS SIMPLIFIED BY BEAM METHOD.....55-71

JAMES CHINN — May 1959, pp. 1183-1192 (V. 55)

The "beam method" of analyzing cylindrical shells is briefly explained. Formulas are presented for analyzing single shells without edge beams and interior barrels of multiple shells. A numerical example illustrates use of formulas. Method applies to continuous as well as simply supported shells.

FLEXURAL AND COMPRESSIVE STRENGTH OF CONCRETE AS AFFECTED BY THE PROPERTIES OF COARSE AGGREGATES 55-72

M. F. KAPLAN — May 1959, pp. 1193-1208 (V. 55)

Experiments were conducted to determine the effects of the properties of 13 different coarse aggregates on the flexural and compressive strength of concrete. Depending on the aggregate, differences of 40 percent in flexural strength and 29 percent in compressive strength were obtained for concrete of the same mix proportions. Statistical analysis indicated that the shape, surface texture, and modulus of elasticity of the aggregates were the main causes of variation in concrete strength. The greater the strength of the concrete, the more important these effects became. The elastic modulus of the aggregate was, in general, the most important single factor affecting flexural strength, although for concrete with the greatest strength, surface texture had the predominating effect. Surface texture was the most important aggregate property influencing concrete compressive strength. Because the aggregate strength was generally greater than that of the concrete and differences in the water-absorptive capacities of the aggregates were small, no relationship was found between the strength or water-absorptive capacity of the aggregates used and the strength of the concrete. However, this should not be assumed as evidence that coarse aggregates of low strength or high water-absorptive capacity will not affect concrete strength.

INTERNAL SHIELDING CONSTRUCTION AT SHIPPINGPORT NUCLEAR POWER PLANT 55-73

L. EARL TABLER, JR. — May 1959, pp. 1209-1214 (V. 55)

Concrete walls 4 to 6 ft thick, constructed inside 50-ft diameter steel chambers at the Shippingport, Pa., atomic power plant, serve as shielding against radioactivity. Paper describes unusual construction practices occasioned by limited access to chamber interiors. Concrete was a standard density, 3000-psi mix made with Type I S cement.

FURTHER TESTS OF DYNAMICALLY LOADED BEAMS 55-74

F. T. MAVIS and J. J. STEWART — May 1959, pp. 1215-1224 (V. 55)

Twenty-seven beams, identical except for amount and grade of reinforcement, were tested to destruction by spring-actuated impulse loads applied at the third-points of an 8-ft simple span. Loads, reactions, bar strains, and deflections were recorded simultaneously throughout each test by a motion picture camera at speeds of 2000 pictures per sec. Frame-by-frame analysis of the pictures shows: (1) all beams were destroyed when deflection reached about 6 in. (or 6 percent of span length) at midspan; (2) at the onset of destructive failure steel strain was less than 4 percent; (3) no reinforcing bar fractured in any test; and (4) beams with hard grade bars consistently outperformed beams with intermediate or structural grade bars under otherwise identical conditions.

USE OF HIGH-STRENGTH STEEL IN REINFORCED CONCRETE 55-75

GEORG WASTLUND — June 1959, pp. 1237-1250 (V. 55)

In Europe the use of high-strength steel for reinforcing bars is increasing and is, to a degree, replacing reinforcement made of mild steel. Both Austria and Sweden have developed reinforcing steel with high yield points (50,000 psi or more), one employing cold working and the other employing "natural" elements, i.e., more carbon and better alloys. This steel increases working stresses and, generally, eliminates the need for end hooks. Failure precautions, crack formation, and deflection considerations limit the full use of this steel.

INFLUENCE OF SEA WATER ON CORROSION OF REINFORCEMENT..55-76

R. SHALON and M. RAPHAEL — June 1959, pp. 1251-1268 (V. 55)

Over 400 reinforced mortar prisms mixed with water from the Mediterranean Sea were tested for corrosion of reinforcement at ages ranging from 3 months to 4 years. Variables studied were water-cement ratio, cement content, and storage conditions. The pH necessary for inhibition of corrosion by hydroxyl ions under different storage conditions was determined, and pH values of mortars and cement pastes made with sea water and fresh water were measured.

The reinforcement was corroded in all specimens stored in moist air, but for mortar prisms stored in sea water or tap water practically no corrosion of reinforcement was observed. No regular relationship between consistency or cement content on the one hand and amount of rust on the other was found. Corrosion did not halt but, with one exception, was still increasing as the study ended. Conclusion is drawn that sea water used for mixing mortar or concrete for air-exposed reinforced structures tend to make reinforcement highly vulnerable to corrosion.

WATERSTOPS FOR JOINTS IN REINFORCED CONCRETE 55-77

B. KELLAM and M. T. LOUGHBOROUGH — June 1959, pp. 1269-1286 (V. 55)

Waterstops are grouped into six categories, depending on shape and material. Studies have indicated that a properly compounded polyvinyl chloride is likely to outlast many of the materials used in the past.

An investigation of the watertightness of various shapes and sizes of waterstops is described, from which it is concluded that "flat corrugated" and "flexible metal" types are superior to "dumb-bell' and "metal plate" waterstops.

Physical properties of waterstops are discussed with reference to their ability to withstand rough treatment during installation and their ability to accommodate joint movements. Waterstops of various shapes and materials are compared with regard to ease of installation. Methods developed for cutting, splicing, and installation of pvc waterstops are outlined.

FATIGUE AND STATIC STRENGTH OF STUD SHEAR CONNECTORS.......55-78

BRUNO THURLIMANN — June 1959, pp. 1287-1302 (V. 55)

L-connectors and straight studs were tested in push-out specimens to get data on the fatigue behavior of stud shear connectors. Specimens were also tested under static loading. Based on these and previous tests, criteria are suggested for the design of composite beams with ½-in. L-connectors.

EFFECT OF POWDERED MINERALS AND FINE AGGREGATES ON THE DRYING SHRINKAGE OF PORTLAND CEMENT PASTE 55-79

KENNETH M. ALEXANDER and JOHN WARDLAW — June 1959, pp. 1303-1316 (V. 55)

The extent to which fine aggregate and powdered minerals of cement fineness affect the drying shrinkage of portland cement paste was studied under a wide range of conditions. The water and powdered admixture contents of the paste were varied both separately and simultaneously, and the effect of gradually increasing the size of the powdered mineral grains until the admixture became an aggregate was studied. Results show that if the portland cement in a paste is partially replaced by powdered basalt, of cement fineness, and at a constant water-(cement + admixture) ratio, the effect on drying shrinkage represents a balance between the individual contributions arising from the simultaneous changes in the water-cement and admixture-cement ratios. An equation is given which relates both shrinkage and strength changes to changes in the water and admixture contents.

When the effect of aggregate on drying shrinkage is considered in terms of the elastic constants of the embedded particle and the surrounding medium, some distinction should be made between the restraint imposed by rock particles small enough to fit between individual clinker grains, and that imposed by the same volume of rock in the form of grains or pebbles large enough to displace whole zones of clinker grains.